SCIENCE AND CULTURE

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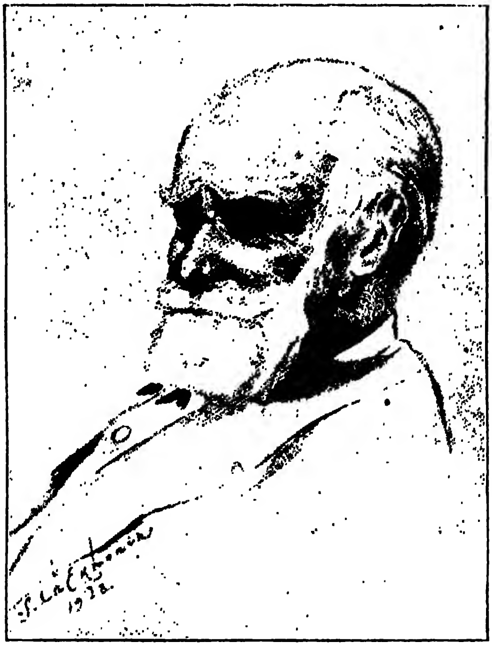
BEQUEST OF PAVLOV TO THE ACADEMIC YOUTH OF HIS COUNTRY*

WHAT can I wish to the youth of my country who devote themselves to science?

Firstly, gradualness. About this most important condition of fruitful scientific work I never can speak without emotion. Gradualness, gradualness and gradualness. From the every beginning of your work, school yourselves to severe gradualness in the accumulation of knowledge.

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis. Howsoever this soap-bubble will rejoice your eyes by its play it inevitably will burst and you will have nothing except shame.



IVAN PETROVITCH PAVLOV

School yourselves to demureness and patience. Learn to inure yourselves to drudgery in science. Learn, compare, collect the facts!

Perfect as is the wing of a bird, it never could raise the bird up without resting on air. Facts are the air of a scientist. Without them you never can fly. Without them your "theories" are vain efforts.

But learning, experimenting, observing, try not to stay on the surface of the facts. Do not become the archivists of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.

Secondly, modesty. Never think that you already know all. However highly you are appraised, always have the courage to say of yourself—I am ignorant.

Do not allow haughtiness to take you in possession. Due to that you will be obstinate where it is necessary to agree, you will refuse useful advice and friendly help, you will lose the standard of objectiveness.

Thirdly, passion. Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.

[* We are thankful to Prof. A. V. Hill for communicating to us the above "Bequest" of the great Russian Physiologist Prof. I. P. Pavlov (died 1936) to the young scientists of his country. We feel that the "Bequest" is for all humanity. —*Ed., Sc. & Cul.*]

PROF. HILL ON PRINCIPLES OF ORGANISATION OF SCIENTIFIC RESEARCH

PROF. A. V. HILL, Secretary of the Royal Society of London, has been in this country for some time, having been invited by the Government of India to advise them about the organisation of scientific research in India. At the invitation of the Indian Science Congress he was kind enough to deliver on the 5th January, 1944 before a crowded gathering of scientists at Delhi an address on the scientific organisation, official and unofficial, in the United Kingdom. Through the courtesy of Prof. Hill and the authorities of the Indian Science Congress, we have been enabled to reproduce this lecture in full in the current issue of the journal. Coming from a great scientist and a great investigator and one who has been Secretary of the Royal Society of London for several years and has been in intimate contact with every scientific institution and organisatin in his country, his lecture is full of information which are very badly needed in this country at the present moment to clarify our own ideas on these points. His opinions, which are the result of years' of experience, are therefore entitled to the most serious consideration by officials and non-officials alike in this country. Let us therefore examine the principles as enunciated in detail and compare them with the conditions in this country.

There will be no difference of opinion about the part science is destined to play in the development of this country during the post-war period provided a scheme of development is decided on, hence it is extremely necessary that scientific research is properly organised. Prof. Hill's lecture therefore comes at an opportune moment.

Prof. Hill maintains that progress of science and of its application to public welfare depends upon four M's

MEN, MATERIAL, MONEY,
MACHINERY OF ORGANISATION

He confined his remarks to the last item possibly because men and money are available in plenty in the United Kingdom. But is that the case in this country? The source of supply of men who are capable of doing scientific work are the universities, technical institutes, and institutions of university rank and other research organisations. Not every one of these can supply the proper personnel but only such as have organised Research Schools in pure and applied sciences and have taken steps to maintain them on proper scale. Prof. Hill did not say how men are trained and secured for this purpose in his own country, possibly because that phase of struggle is already over there. But can that be said of this country? Before 1916, the Calcutta University, and before 1921, most other universities of India had not recognised establishment and maintenauce of research schools as one of their obligations. It is true that after the reforms of 1921, most universities have tried to organise schools of research, but what has been the experience of Indian men of science as research workers and directors of scientific research? Most of the prominent research workers are without proper laboratories, grants and other amenities which alone can enable them to develop the lines of activity in which they have specialized. In England and elsewhere in the world, research schools have been methodically fostered by the award of sumptuous grants by the State and private organisations to professors who have developed distinct lines of activities of their own and ample provision has been made for those who receive training under them in the form of employment in the research institutions and scientific services which have sprung up since the last war. But all prominent Indian scientists who have tried to develop schools of their own have a painful experience. It is not because that there has been a lack of young aspirants after scientific distinction. The Indian youth has been always attracted by the glamour of research, for knowledge and learning has always been highly prized in this country, but it has been often his experience that after he has spent a number of years on some problem, made substantial contribution to its solution and got his doctorate on the subject, he has found it extremely difficult to get any suitable employment and is forced to t ke up a post where he cannot do any scientific work or develop his ideas. The preparation stage for doctorate is usually one of training in methods of scientific investigation and hardly enables a scholar to find out the problem in which his future life work will lie: further no problem, even if found, delivers its secret unless one is long at it. The research workers in this country have not infrequently to give up his work at the most productive part of his life owing to absence of any long term research fellowships. Further so many research workers have remained unemployed or without suitable employment for years that for some years past youngmen with brilliant university careers prefer to seek other lines where prospects of earlier and more remunerative employment exist. We cannot afford to ignore *this partial drying up* of the source of supply of trained personnel for scientific work, this can only be stopped by opening more avenues for the employment of the trained re-

search worker and by the creation of long term fellowships under distinguished professors.

The next M is money. We need hardly make any comment on the insufficiency of monetary grant for research in this country. The universities have got limited budgets and every professor keen on developing his line of research has to wage constant war with the university authorities or be satisfied with the *Nirvana* of his career, as many prefer to do, as a research worker. Only a small percentage survive the struggle. No grants are forthcoming from any central organisation for research as in the United Kingdom, except for applied sciences to a limited extent nor are there any such large scientific foundations like the Rockfeller and Carnegie in the U. S. A. or the Nuffield Trust in the United Kingdom. No Indian university to our knowledge has yet been able to establish long term Fellowships which are needed to bring out the best in a trained worker. The Government grant on all headings would not amount to more than 50 lakhs and much of it is spent on administration. There should be a sumptuous grant from the Central exchequer to the Universities for research under the heading Universities Research Grant, and this should be administered by a body of scholars as in the United Kingdom.

The third and fourth M's are material and machinery of organisation. Probably by material, Prof. Hill means places of research and their equipment. It is known to everyone that the existing material is extremely poor and in spite of years of agitation, the various national laboratories vital for public welfare and development of national resources have not seen the light of the day.

Machinery of Organisation.—Prof. Hill maintains that good Government depends on a proper balance and reaction between individual enterprise and initiative on the one part, and State enterprise and control on the other, and this is as true of science as of any other field. He has explained how this is secured in England, and the method has become almost standardised. Let us see what the method is . It will be obvious from a perusal of Prof. Hill's lecture that since the last war, all countries follow almost the same principles in spite of the apparent discrepancies in designation. In every country a body of elder scientists like the Royal Society of London in England or the National Academy of Sciences, Washington U. S. A. or the Academy of Sciences in U. S. S. R. is entrusted with the task of coordinating the work of independent scientific organisations on the one hand, and Government organisations on the other hand, is given certain statutory powers by the Government and is consulted on all matters of policy regarding science and its application.

This body of elder scientists is at the apex of the pyramid of scientific societies devoted to particular subjects, and other learned bodies, and form the channel of communication between the Government, and the general body of scientists represented by these societies and learned bodies. Where such a body of elder scientists had not previously existed, as in the case of U. S. A., or Japan, it has been brought into existence by the order of the highest dignitary of the State and endowed with the requisite powers (*e.g.* the National Academy of Sciences, Washington, or the Imperial Academy of Sciences, Japan)

In India, within the last twenty five years, a large number of scientific societies and academies, had been formed, and have been functioning. In their formation, and management official and non-official elements have freely participated in a spirit of true comradeship, and loyalty to the subject. But such splendid organisations have not yet been utilized by the Government in any of its enterprises so far, and the machinery of organisation so far set up completely violates Hill's principle No. 1. A few scientists are sometimes called to Government committees or councils for advice, but such actions are always taken on the personal initiative of the H. M's or their secretaries.

Secondly, though for administrative and historical reasons some of the Government research institutions may be under different responsible Ministers, the tendency in England has been that research which applies to more than one department is organised outside any department and centrally, directly under an important Minister because as Prof. Hill remarks inter-departmental boundaries are almost as impenetrable in England as elsewhere and this results in lack of co-operation between the different research organisations and leads to loss of efficiency and usefulness. In England all the three chief departments of research dealing with industry, medicine and agriculture are under the central direction of the Lord President of the Council.

The Lord President, and through him the Cabinet, is kept in active touch with the actual research work by the institution of a Scientific Advisory Council* consisting of six members who are three officers of the Royal Society, *viz.*, the President,

* THE WAR CABINET SCIENTIFIC ADVISORY COMMITTEE

The Committee was appointed in October 1940 by the Prime Minister, the late Mr Neville Chamberlain as the Lord President of the Council, after consultation with the Royal Society. Lord Hankey, the Minister without Portfolio, was appointed Chairman of the Committee while Prof. W. W. C. Topley, a distinguished fellow the Royal Society with a colleague from the Offices of the War Cabinet, were to serve as Joint Secretaries.

Secretary, and another, and the three secretaries of the Department of Scientific and Industrial Research (D. S. I. R.), Medical Research Council (M.R.C.) and the Agricultural Research Council (A.R.C.). Thus the proper balance and reaction between individual enterprise and initiative on the one part and State enterprise and control on the other is maintained.

When we compare these organisations with those in India we are at once struck with some fundamental differences. Though we have bodies corresponding to D.S.I.R., M.R.C. and A.R.C., they are organised and controlled under quite different principles. The Chief Executive Officers of the Indian organisations are very seldom scientific men called from active research. The Chief Executive Officer of the I.C.A.R. is styled Vice-Chairman and the next administrative officer is styled Secretary; they have been always Civil Servants generally with no pretensions or knowledge of agricultural science. This violates Hill's principle No. 4 in a very flagrant way. For the I.R.F.A., which corresponds to the M.R.C., the constitution is still worse. Here public health service and medical research are lumped together while in England they have wisely enough been kept in distinct compartments. The Chief Executive Officer, of the I.R.F.A., who is the Public Health Commissioner for India has often been a man without any research experience. The Board of Scientific and Industrial Research for the first four years of its existence had a very curious and cumbrous constitution which we had very often criticised in these columns; the so-called Director of Scientific and Industrial Research was nothing better than a Technical Adviser and no executive action could be taken unless files passed through a maze of secretarial channels in charge of over-worked, and otherwise employed secretaries. These constitutions* which were evolved by Civil Servants in the Secretariat and the Hon'ble Members of the Government of India most of whom had no knowledge of scientific organisations of other countries and certainly had never been appreciative of the spirit of science, were extremely complicated but they had one object in view, that is, "Do not trust the scientific men with any real administrative power." Further the three departments are under three different members of the Viceroy's Cabinet, and most of the scientific services are distributed through different portfolios under the present arrangement, and there is no central direction or coordination as demanded by Hill's principle No. 2.

Further our experience has been that though the Hon'ble Members and secretaries can hardly find time to give serious attention to the work of the scientific research departments under their care, they are hardly prepared to part with power.† Sir J. C. Ghosh referred to the wish of Lord Reading as Viceroy to set up something like a Planning Committee; and such wishes have been expressed by many Honourable Members past and present . . . . and politicians and widely advertized and glibly talked about. The levity of these talks show that few realize the immensity of the task. Thousands of experts have to be mobilized if the thing is to materialize, and their labours have to be collated, but 'inter-departmental boundaries are impenetrable' to quote Prof. Hill, and there can be no co-ordination or efficiency under the present arrangement. If probably the principle be accepted that every subject should have a section on Research, and another on Service and Development, and the latter ones were distributed under different portfolios, while Research was placed under one Minister of the Cabinet rank, the organisation for National Planning would take a shape from which some real work can be expected.

As we have very often remarked, science is one and the same all over the world and if scientific research is to bear any fruit, its organisation and direction must be guided by the principles which have been formulated in such clear terms by Prof. Hill. We believe that the National Institute of Sciences of India which is the premier body of senior Indian scientists has given the right lead to the country by passing the resolutions for the creation of a National Research Council. If they are properly implemented

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The terms of reference of the Committee are:

(a) to advise the Lord President on any scientific pro-problem referred to them;

(b) to advise Government departments, when so requested, on the selection of individuals for particular lines of scientific inquiry or for membership of committees on which men of science are required;

(c) to bring to the notice of the Lord President promising new scientific or technical developments which may be of importance to the war effort.

The members of the Committee at the time of its appointment were:

1. Lord Hankey, G.C.B., G.C.M.G., G.C.V.O., Chancellor of the Duchy of Lancaster (Chairman).
2. Sir William Bragg, O.M., K.B.E., President of the Royal Society (since dead).
3. Dr E. V. Appleton, F.R.S., Secretary of the Department of Scientific & Industrial Research.
4. Sir Edward Mellanby, K.C.B., F.R.S., Secretary of the Agricultural Research Council.
5. Sir Edwin Butler, C.M.G., F.R.S., Secretary of the Medical Research Council.
6. Prof. A. V. Hill, O.B.E., F.R.S., M.P., Secretary and Foulerton Research Professor of the Royal Society.
7. Prof. A. C. C. Egerton, F.R.S., Secretary of the Royal Society and Professor of Chemical Technology in the Imperial College of Science and Technology.

* Sir Walter Fletcher was consulted when the construction of the I. R. F. A. was framed, but it is certain that his advice was not followed.

† It is reported to have been amended in recent years.—Ed., *Sc. & Cul.*

they will be found to satisfy all the principles enunciated by Hill. These resolutions as amended in the Delhi meeting are now quoted below:—

(1) That it is necessary to establish at an early date a National Research Council of India under the statutory authority of the Government of India.

(2) The purpose of the National Research Council shall be

(*a*) to plan and watch over the main lines of research and technical developments in accordance with national needs to see that the application of science to the public welfare is adjusted to some consistent plan, to advise the Government on a common policy and to ensure that available resources for research and developments are distributed to the best advantage of the country,

(*b*) to advise and help relevant authorities and Institutions regarding the training and supply of scientific personnel for pure and applied research, and

(*c*) to distribute grants for promoting approved researches, for the maintenance of selected research scholars, for scientific publication and other purposes.

The President of the National Research Council shall be a member of the Viceroy's Cabinet.

For the performance of its functions, the National Research Council shall, in consultation with non-official scientific organisations, Universities and Institutions of a University rank, Scientific Departments of the Government and Federations of Chambers of Commerce, constitute the following Boards of Research, each of which will be responsible within its own particular sphere for giving effect to the policy of the National Research Council.

(*i*) Board of Scientific Research (Mathematics, Statistics, Physics, Chemistry, Botany, Zoology, Geology, Geography, Psychology, etc.).

(*ii*) Board of Agricultural Research (soils, crops, animal husbandry, fishery and forestry).

(*iii*) Board of Medical and Public Health Research including Medical Science.

(*iv*) Board of Engineering Research including Mining, Metallurgy and such other Boards as may be considered to be necessary.

For the purpose of its work each Board will be authorised to constitute Research Committees for all important subjects, to settle the objects of the research, indicate the individuals or organisations which could undertake the several component parts of the enquiry, receive and coordinate the information, make it available to those who will turn it to advantage to form national plan into which all who are in position to contribute information can fit the particular lines on research. Governing bodies of the National Research Laboratories when established shall be constituted in consultation with the relevant research committees.

The National Research Council shall work in clo operation with the development organisations in the country.

To enable effect being given to the policy of scientific development determined by the National Research Council the Government should make an annual grant of at least 5 crores of rupees.

Let us hope that the Government of India will see their way to give effect to these resolutions, and in doing so, will be guided by the principles enunciated by Prof. Hill. Some critics have invited our attention to the following passage in the speech "Indeed, if I may say so, it is for you, the independent scientific people of India, to get together and ask clearly *with a single voice* for what you think is required." They have pointed out that the phrase may be interpreted by official quarters in an 'Ameryian-*cum*-Halifax' sense. But we believe that that was not Prof. Hill's intention. He has applied thermodynamics to the human system, and is well-aware of the fundamental maxim of thermodynamics "that it is impossible to convert the whole of heat energy to ordered work, unless you reach the absolute zero of temperature and that absolute zero is theoretically *impossible* to attain." The '*Single Voice*' is impossible to attain in any country of the world, including the United Kingdom, but there cannot be the slightest doubt that the assembly of scientists who passed the resolutions on the formation of the National Research Council was as near 'Single Voice' as could be attained in any country of the world.

THE SCIENTIFIC ORGANISATION, OFFICIAL AND UNOFFICIAL, IN THE UNITED KINGDOM*

A. V. HILL,

SECRETARY, ROYAL SOCIETY OF LONDON

THE MAN OF SCIENCE

MAY I introduce this lecture by a word of greeting from British scientific people to their Indian colleagues; and then a word of comment on both of us. We scientists are a peculiar lot. Before the last war people used to think we were a bit mad—we were interested in such funny things and for such funny reasons and some professors (not all of them) had long hair and beards, wore strong spectacles, looked like nothing on earth and were quite inexperienced in the ordinary affairs of life. The last war produced a change in this idea of us, and we became magicians. The scientists were found to be able to do all kinds of things that other people couldn't and the public and its leaders (who prefer to believe in magic anyhow) went to the opposite extreme and supposed that science could do everything. The result was that all sorts of quacks and frauds and magic mongers got going and tried to put it across in the name of science. Between the wars the position tended to revert though not completely: and in the present war the public has realised once again the extreme importance of scientific knowledge and scientific research to the community.

The attitude, however, of some administrators still is that although science may get them out of a hole when things go wrong, scientists as a whole are a funny lot, that science should be, as the saying is, "on tap and not on top". Scientists are still paid considerably less than administrators of equal or less ability and standing. Our claim is not yet admitted that we ought to be regarded as equal partners with other people of similar expert knowledge in deciding policy. We are getting on, however. We are usually rather poor and don't much mind provided we are allowed to do our work; on the whole, we don't much care about public honours and awards; most of us hate looking important or being called Sir by our younger colleagues; we don't generally believe what we are told; we know that things aren't usually what they seem; we're fairly careful what we say; and we're generally honest.* In spite of these disadvantages, however, we have much more influence in the end than is commonly supposed;

Prof. V. Hill

and the public is realising and the politicians will realise in time that science and scientists must really be taken rather seriously in the modern State.

ETHICS OF SCIENCE

Probably that process has gone further in England than in India, but I expect the trend here is very much the same. Science is on the rising tide of its fortunes, or at least of public appreciation, here as there. It is very important, therefore, that we should work together on common problems and adopt a common ethical standard of what a scientist should or should not do. The oldest science of all—

* Popular lecture to the Indian Science Congress on Wednesday the 5th of January 1944. The editors express their thanks to Prof. A. V. Hill and the authorities of the Indian Science Congress for permission to publish this article.

* "Is honesty a disadvantage?" This admission may sound queer, coming from a scientist of Prof. Hill's eminence but this is also the experience of many of us.—ED., *Sc. & Cul.*

except perhaps astronomy—is medicine, and for thousands of years, medicine has everywhere adopted a high ethical standard for its practitioners. There is a universal brotherhood of medical people, of medical ethics, of medical thought and medical practice. This brotherhood must be recognised also for us scientists. Our interests are common, our needs are common, the services we can render to our fellow men are common and the ethical standards of our behaviour as scientists should be common too. Feeling all this very strongly I have for many years been concerned—both inside and outside my laboratory—with the international aspects of science. This feeling, this conviction that science is a common interest of humanity, has led one into many interesting places and situations—and sometimes I admit into disputes, for example, with Nazis, Fascists and Anti-Semites. It has led me now to one of the most interesting situations of all and I am grateful to the fate and the friends that have brought me to a country so rich in possibilities, both of the improvement of scientific knowledge and of the application of science to public welfare.

We are all in this business together. We can all help each other by our experience, our special knowledge and talents and the special resources at our disposal. If we in Britain are able to help you more at the moment, we know very well that the traffic is already—and will increasingly be—both ways. To take a single example, your knowledge and experience will have a very special application to the problems of our colonial territories. Moreover, in what is sometimes called pure science each kind of people has a special contribution to make. The long artistic and spiritual tradition of India is bound to give a particular bias and direction to yours. That bias will not be given to the facts themselves as determined by experiment: they are Nature's own reply to our questions. The bias will be to the planning of the experiments and the interpretation of the results. In science there is room for all kinds, for practical men and dreamers alike; provided that we recognize always the common ground of the appeal to Nature by experiment, provided that we agree that honesty, frankness, forbearance and a collaborative spirit are the *sine qua non* of all progress.

Four M's essential for success of Organised Scientific Research

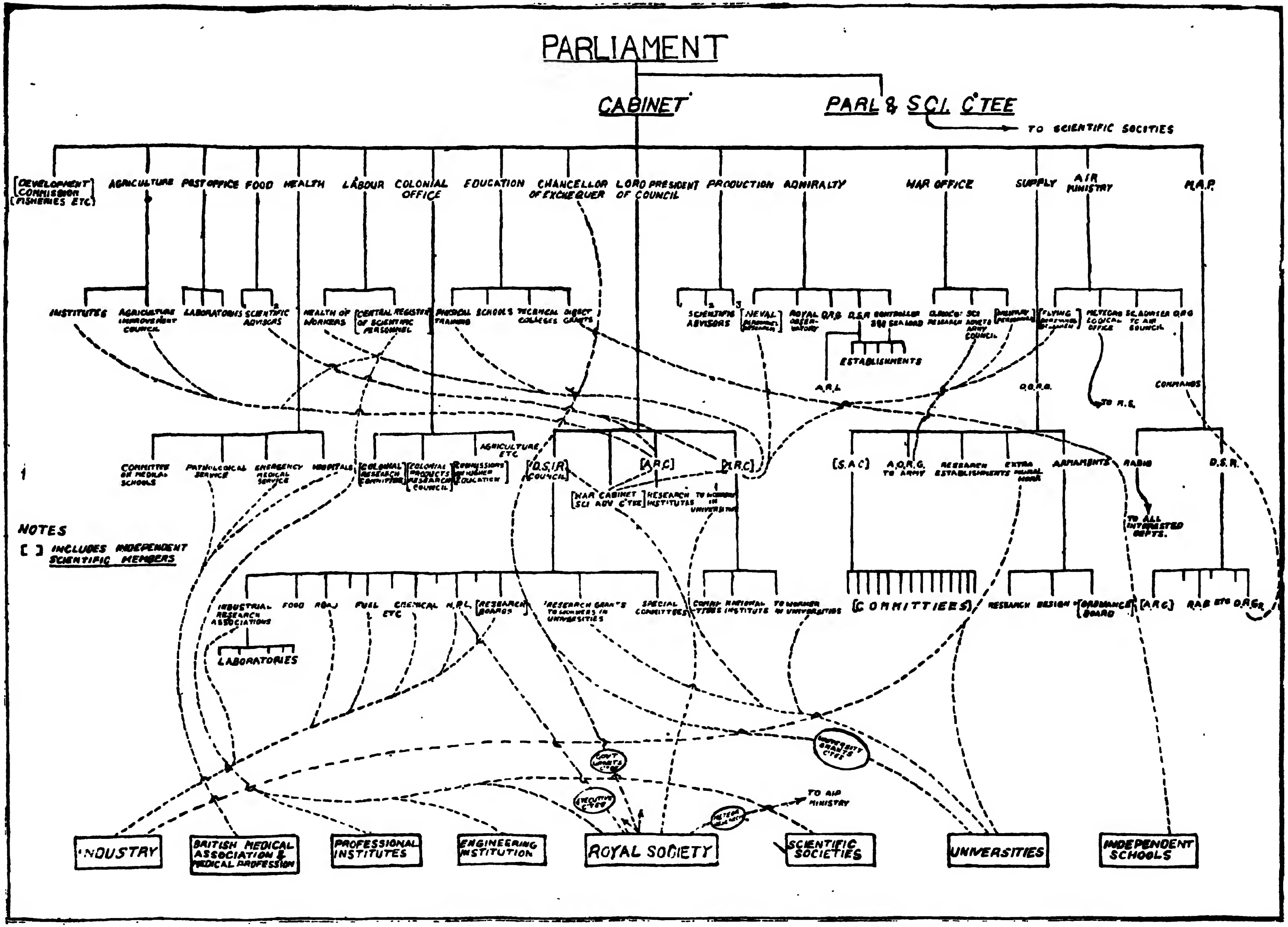
Men, Money, Material, Machinery (of Organisation)

The progress of science and of its application to public welfare depends upon four M's, Men, Money, Material and Machinery of Organisation. They are equally important and the supply of each of them is bound up with all the others. It is about the last of these, the machinery of organisation in the United Kingdom, that I am to speak today. I hope it may be of value to you in planning your own organisation to have the family tree, as one may call it, of ours set out in a diagram. I am very grateful to Sir S. S. Bhatnagar, Director of Scientific and Industrial Research, for the help of his Department in getting it prepared. It is by no means complete and it may not be in all respects quite accurate. It is still growing and changes occur in it from month to month. On the whole, however, it gives a pretty good idea of the situation.

In looking at it you must bear in mind the fact that it evolved and grew, usually without much planning beforehand. It is, therefore, very complicated like all living things. Every biologist knows that in living organisms much is there for historical reasons. If an animal or a plant were to be deliberately planned beforehand it would probably be very different. Our system as you see is very complicated and you would be wise in planning yours to aim at something simpler. On the otherhand our system works, and works now pretty well, though it could really be improved a good deal yet. It works at the moment partly because of the very high quality of the men temporarily engaged in it during the war who for the most part will not remain in the official side of it afterwards. It works also because it embodies certain fundamental principles which I will describe. You would be wise to emphasise those principles in planning your own organisation. If you do, and if you can devise something less complicated than ours and something which will work even when men of the highest scientific quality are to a large extent employed outside the official part of it, you should be able to make something which will be of the greatest value in the developments both of pure science, and of that application of science to public welfare which your country so greatly needs.

Co-operation between the Official and the Non-official

You will see that I have arranged our organisation in two layers: official and unofficial. In the United Kingdom we have a large number of old and well established institutions, often powerful, sometimes wealthy and generally highly respected, which are entirely independent of the Government. My Socialist friends call me a Tory—my Tory friends call me a Socialist in fact I have only one political principle that I am aware of, *viz., that good Government depends on a proper balance and reaction between individual enterprise and initiative on the one part and State enterprise and control on the*


PARLIAMENT
CABINET
PARL & SCI. C'TEE
TO SCIENTIFIC SOCITIES
[DEVELOPMENT COMMISSION (FISHERIES ETC)]
AGRICULTURE
POST OFFICE
FOOD
HEALTH
LABOUR
COLONIAL OFFICE
EDUCATION
CHANCELLOR OF EXCHEQUER
LORD PRESIDENT OF COUNCIL
PRODUCTION
ADMIRALTY
WAR OFFICE
SUPPLY
AIR MINISTRY
M.A.P.
INSTITUTES
AGRICULTURE IMPROVEMENT COUNCIL
LABORATORIES
SCIENTIFIC ADVISERS
HEALTH OF WORKERS
CENTRAL REGISTER OF SCIENTIFIC PERSONNEL
PHYSICAL TRAINING
SCHOOLS
TECHNICAL COLLEGES
DIRECT GRANTS
SCIENTIFIC ADVISORS
ROYAL OBSERVATORY
ESTABLISHMENTS
A.R.L.
O.R.S.
COMMANDS
TO R.E.
COMMITTEE OF MEDICAL SCHOOLS
PATHOLOGICAL SERVICE
EMERGENCY MEDICAL SERVICE
HOSPITALS
[COLONIAL RESEARCH COMMITTEE]
[COLONIAL PRODUCTS RESEARCH COUNCIL]
[COMMISSIONS ON HIGHER EDUCATION]
AGRICULTURE ETC
[D.S.I.R. COUNCIL]
[A.R.C]
[M.R.C]
[WAR CABINET SCI ADV C'TEE]
RESEARCH INSTITUTES
TO WORKERS IN UNIVERSITIES
[S.A.C]
A.O.R.G. TO ARMY
RESEARCH ESTABLISHMENTS
EXTRA MURAL WORK
ARMAMENTS
RADIO
D.S.R.
TO ALL INTERESTED DEPTS.
NOTES
[ ] INCLUDES INDEPENDENT SCIENTIFIC MEMBERS
INDUSTRIAL RESEARCH ASSOCIATIONS
LABORATORIES
FOOD
ROAD
FUEL
CHEMICAL ETC
N.P.L.
[RESEARCH BOARDS]
RESEARCH GRANTS TO WORKERS IN UNIVERSITIES
SPECIAL COMMITTEES
NATIONAL INSTITUTE
TO WORKERS IN UNIVERSITIES
[COMMITTIEES]
RESEARCH
DESIGN
[ORDNANCE BOARD]
[A.R.C]
R.A.E ETC
UNIVERSITY GRANTS C'TEE
TO AIR MINISTRY
INDUSTRY
BRITISH MEDICAL ASSOCIATION & MEDICAL PROFESSION
PROFESSIONAL INSTITUTES
ENGINEERING INSTITUTION
ROYAL SOCIETY
SCIENTIFIC SOCIETIES
UNIVERSITIES
INDEPENDENT SCHOOLS

other. Where the balance lies at any moment is a matter for discussion, compromise and agreement: but it is the greatest and most disastrous folly to suppose that there is a fundamental antagonism between the two parts. The wisdom and public spirit of private citizens, individually and collectively through their private organisations, must act and react by friendly advice and helpful criticism with the wisdom and public spirit of officials, individually and collectively through their Government machinery. That is the age-long tradition of the British political and social system and I think it is good. There is a tendency always of course for private citizens to be unwise and selfish, for officials to be pig-headed and unreasonably obsessed with their own machinery and importance. If that became general our system would break down. It works because there are sufficient people on both sides who believe in friendly give-and-take between free individuals and their free institutions on the one part and the organised machinery of the State on the other.

The Position of Royal Society of London

This is as true of science as of any other field of human activity and we are fortunate in the United Kingdom in having a great number of private organisations, powerful and well established, representing collective scientific wisdom and effort outside the Government system. Of all these, on the purely scientific and technical side, the Royal Society founded 281 years ago (1663) is the elder brother and example: there are learned societies of all kinds and engineering and professional institutions. On the educational side there are the old established "public schools", going back some of them for many centuries, and the older universities. On the medical side there are the Royal Colleges of Physicians and Surgeons, the voluntary hospitals and more recently founded institutions such as the British Medical Association and the Royal Society of Medicine. To this set of old and well-established bodies, with their long tradition of independent enterprise and existence, many new ones are always being added more or less on the same model; the newer universities, the newer schools etc. Many of these—though not all—now-a-days are receiving substantial State support: but nearly always when this is done a *buffer of some kind is interposed to prevent Government support from becoming Government control.* For example the universities receive a substantial Government grant from the Treasury and will have to receive a much greater one if they are to carry on effectively: but the University Grants Committee, *a body of independent scholars and scientists advising the Treasury*, sees that the distribution of that money does not mean that the universities will lose their own characteristic freedom and independence. An extreme example is seen in the case of the National Physical Laboratory. Founded initially under the influence of the Royal Society (1901) it was later taken over and is now financed almost entirely by the Department of Scientific and Industrial Research. Yet the Royal Society still appoints the Executive Committee which controls and guides the work of the N. P. L., and appoints and dismisses the staff, all except the Director himself who is appointed by the Lord President of the Council in consultation with the Royal Society.

The War Cabinet Scientific Advisory Committee

This influence goes to a very high level. The War Cabinet Scientific Advisory Committee (estd. 1939) consists, as to half its membership of the three principal officers of the Royal Society and reports directly to the Lord President of the Council who is himself a member of the War Cabinet. It advises the Government on matters of general scientific policy and on special appointments. The Councils of the three Research Departments (D.S.I.R., M.R.C. and A.R.C.) who direct their work consist in the main of independent scientific people appointed from outside Government circles after consultation with the President of the Royal Society. The many lines of connection given in the diagram show how intimate is the reaction between science and its applications under the Government, on the one side, and science and applied science in organisations entirely independent of the Government on the other.

The First Principle of Organisation

The first principle of successful scientific organisation are:—

(1) *That there should be a number of large powerful and well organised institutions representing the collective opinion and knowledge of scientific and technical people as a whole.*

(2) *That there should be a frank, friendly and welcome collaboration of these institutions and their members in the scientific activities of the Government.*

(3) *That there should be the support when necessary, but not the control, of a good many of these institutions by the Government.*

The Second Principle: Central Direction of Research

The second principle is the existence of a central scientific organisation outside any ordinary department of the Government directly under an important Minister.

This in itself is not enough—there must be scientific work going on in every Government department to which it applies: but it is also essential that research which applies to more than one department should be organised outside any one department and centrally: *interdepartmental boundaries are almost impenetrable in the United Kingdom as elsewhere.* The organisation under the Lord President of the Council represents this principle in a form which could scarcely be bettered. There are three separate bodies under the Lord President: the Department of Scientific and Industrial Research (D.S.I.R.), the Medical Research Council (M.R.C.) and the Agricultural Research Council (A.R.C.).

The Medical Research Council (M.R.C.)

The M. R. C. was founded in 1914, and its first Secretary was a very distinguished scientific man, the well known physiologist Walter Fletcher, who obtained from the very start a clear admission of his claim that the Council should be authorised to engage in and support any research directed towards the main object of the Council, however unlikely it seemed to produce immediate practical results. This wise policy has been entirely justified by results. The Council has worked mainly by the encouragement and support of research, in medicine and the medical sciences but also of related subjects, in the universities and medical schools of the country: but it has encouraged research also on tropical medicine and it has maintained a first class research laboratory at the National Institute for Medical Research. Any suggestion that good work cannot be done within the walls of Government laboratories is negatived by the fact that Sir Henry Dale, now President of the Royal Society, was awarded the Nobel Prize for physiology and medicine for work done over many years in that Institute. Its workers are regularly interchanged with workers in universities and elsewhere and its whole conduct is similar to that of a research institution in a university. Indeed it is recognised by the University of London as a School of the University and work in it is recognised for higher degrees in the University. The activities of the Medical Research Council are guided by a Council consisting mainly of independent scientific and medical men.

The Department of Scientific and Industrial Research (D.S.I.R.)

The D.S.I.R. was founded on similar principles in 1916 during the last war. It has grown to be a very important organisation indeed, the many activities of which can best be described by the diagram. Its workers also are interchangeable with those elsewhere. Its Council (Scientific Advisory Council) similarly consists mainly of independent scientific men, engineers and industrialists. Its expends considerable sums in making maintenance grants for students in training for research and for encouraging research in universities and elsewhere "of special timeliness and promise". *Its Secretary ranks in pay and status with the chief secretaries of the Government departments*—though he is and will always I hope remain a scientific man. Like the M.R.C. it is assisted by a large number of Boards and Committees of independent experts in various subjects. It maintains a large number of stations and establishments of its own and a very large scientific staff. Its constitution is very flexible—for example when it was desired to establish a liaison officer at Ottawa with the National Research Council of Canada, and no other department, not even the Dominions Office, could think of any way of doing it, the D.S.I.R. just sent Sir R. H. Fowler, F.R.S., famous mathematical physicist, there to represent us. That flexibility comes from being outside any ordinary department with its rigid rules and red tape, and also from the facts (1) that its Secretary has the same status as the chief permanent officers of the other departments and (2) that his Minister is of high rank in the ministerial hierarchy, but not the head of an ordinary Department.

One of its most important activities is the Industrial Research Associations which are joint concerns with organised industry.

The Agricultural Research Council (A.R.C.)

The A.R.C. was founded later than the other two with a constitution and function similar to those of the M.R.C. Recently to complement its activities an Agricultural Improvement Council has been established in the Ministry of Agriculture. This is intended to take the results of research obtained by the A. R. C. and other bodies and to apply them to the practical problems of agriculture. The Agricultural Improvement Council promises to exercise an an important influence in bringing the results of research to practical fruition.

These three Research Councils, by their independence and the relative absence of departmental restrictions and red tape, set a standard and example to research under Government which is most valuable, and we are fortunate indeed in the United Kingdom that so satisfactory an arrangement has been evolved. Its success, however, is not due only to the machinery and organisation—men are just as important as any—it is due largely to two facts which I will exalt to my third and fourth principles.

The Third Principle of Organisation

The third principle is that every scientific organisation should be watched over, advised and guided

or controlled by a Council, Committee or panel largely consisting of independent scientific men.

This has two results, first that all its work is kept in touch with outside scientific ideas and criticism, second that its workers are not shut off from the outside world, but feel that they and their interests are being looked after sympathetically by scientific colleagues, not by pure administrators. This principle is found at work in a good many other parts of our organisation, as can be seen in the diagram. A powerful advisory committee with an active chairman is the surest way of preventing a Government organisation from becoming sticky, sleepy and incompetent. In some parts of the diagram—I will not specify too closely—you can see organisations which hitherto have resisted this principle: by reason of vested interest, fear of being shown up for incompetence, undue obsession about secrecy, etc. The weakness of some of these organisations was more obvious in peacetime and the earlier years of the war than it is now, when a lot of fresh blood and a number of first class people have been introduced from outside. When, however, conditions revert to those of peace, most of these good people will withdraw to their previous jobs and it will be necessary to continue the fight to get some measure of independent criticism and control on the inside of these water-tight compartments.

The Fourth Principle

The fourth principle is that the head of every scientific organisation should himself be a good scientist, not purely an administrator.

This means, I know, that a good research worker is going to be sacrificed, or at least largely removed from his research: I am sorry for him: but the net gain is very great.

The ordinary civil servant, like the ordinary politician, is unfortunately nearly always quite ignorant of scientific matters, and to put him in charge directly of a research organisation is to stultify the whole thing. It is quite untrue that a good scientist is likely to be less competent than any other intelligent, educated man at administration. Some able scientists it is true are incompetent at such things—but so for that matter are some professional administrators: some scientists, however, are as competent as anyone else at administration and some of these must be sacrificed to administration for the good of the rest. Perhaps the fairest and wisest thing might be to appoint the heads of scientific organisations for a limited period only, arranging for them to return to university or research jobs of their own after a few years: thus preventing them from becoming—whether they like it or not—bureaucrats. This would give them the inducement, all the time they are in office, of keeping personal touch with real scientific work against the time when they return to it. Having spent nearly five years now, against my will, far away from my own laboratory, I know the home-sickness which is produced by visiting someone else's. It is a good thing that those who are trying to organise scientific research for others should remain homesick for their own, and look forward to returning to it. What is quite certain is that people who prefer to sit in offices should not be allowed to organise the scientific work of others!

The Fifth Principle

The fifth principle is that of interchange of scientific persons between universities, Government laboratories, industrial and research laboratories and research institutions and enterprises of all kinds.

It is a very good thing for people in universities, who are apt to be a bit high-browed in their attitude, to learn, for example, what excellent work and of what high intellectual quality is done in Government laboratories or industry and be made to find out something about it. It is a very good thing for people in the Government service or industry to learn something at first hand about the latest developments of their science and to be in touch with young students during their years of training. It is a good thing for students to be taught by people who are in touch with the practical problems of the real world. The first condition of interchangeability is a common pension system so that no pension rights are lost in going from one service to another. That to a large extent we already have in England. The other condition is that the need of fresh air and a change of mental diet should be recognised explicitly in all the different scientific services, so that a young man or indeed an older one does not lose by applying to change his job for something more suitable, or to him more interesting. We are trying in the United Kingdom to ensure that the principle of interchangeability of scientific personnel is as widely recognised as possible.

These then are the principles which I should apply in any scientific organisation anywhere. I will illustrate them by referring to the various departments in the diagram. You will see the complexity, the unnecessary complexity as I think, of our scientific set-up; but you will see also how it has been made to work by insisting, so far as vested interests and departmental proprieties allow, on the principles I have recounted. If you can apply the principles in

India and avoid the complexities you will have done well.

At present, if I may make a single comment on your system in India, as shown in the other diagrams, you are avoiding some of the complexities but you are not yet applying—perhaps you have not yet the means to apply—the principles. The latter may not be easy for you but it will happen all right in the end. It means the creation of a much stronger scientific public opinion, the building up of much stronger and more representative institutions of scientific men ; it means inserting science into the machinery of Government at a much higher level than at present. But all this you can and you will do. Don't forget that we too have had our struggles in Great Britain, for instance, I have had to make myself very unpopular now and then by private and sometimes by public criticism of the scientific set-up in various departments.

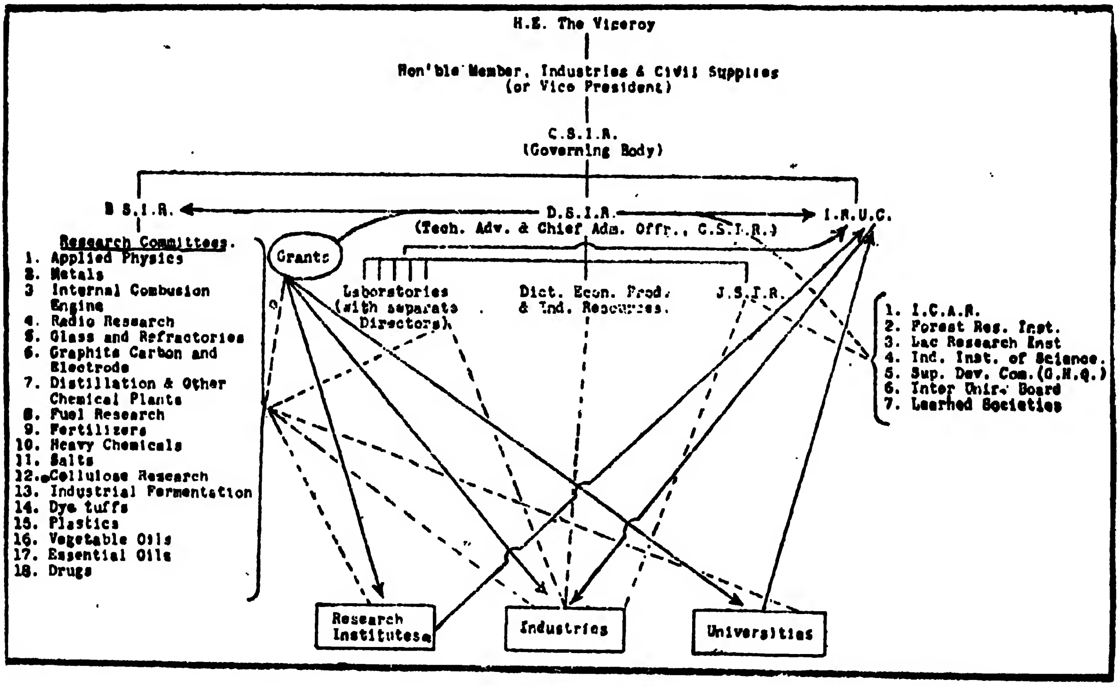


Fig. 2

Prof. Hill, as Public Enemy No. I

Indeed in one department, where certain things were badly wrong and needed urgently to be rectified, it took years of hard work, in private and in public, before things were put right. In that department I was regarded as public enemy No. I and they said of course that I was doing it all for my own private ends—though what those ends were they did not clearly specify.

Sometimes I have felt pretty bad about it all and once made a new beatitude, "Blessed is he who remains innocently in his laboratory and grumbles ; for it is a thankless task trying to put things right". But things do get right in the end if one goes on trying ; and *I am convinced myself that the Government of India is sincerely anxious to do its best for science and its many applications to the public welfare. If they had wanted someone to say that everything was beautiful already in the garden they certainly would have invited somebody else to come and advise them, not one who has had to make himself a public nuisance for several years in England in trying to get a scientific move-on.* Indeed, if I may say so, it is for you, the independent scientific people of India, to get together and ask clearly with a single voice for what you think is required. Your co-operation, your advice, your constructive criticism, individual and collective through your scientific organisations, is what is wanted ; and if you give that collective advice clearly and sincerely and co-operatively, I honestly believe that you will succeed in bringing into existence the kind of national scientific machinery which your country needs.

Note to Prof Hill's Lecture

For the convenience of our readers, we are adding the following notes to Prof. Hill's Lectures particularly for explaining the diagrams. These notes have been prepared by our own staff, and for any omissions or inaccuracies, we are solely responsible. They have been mostly collected from *Nature* and other British scientific journals.

The British organisation can be roughly divided into three sections. The left part deals with the scientific services under the different departments. These are distributed under the different ministries, and have in recent years been linked to active research by the institutions of bodies of scientific advisers. The central part deals with pure peace-time research departments under the Lord President of the Council. Their activities have enormously increased during the War, and the cross linkages show how results of their activities are made available to services and to war-effort. The right hand section deals with the departments directly concerned in the war-effort. Some of these departments date from old times, others are new, and all have undergone considerable expansion during the current war, and the cross linkages show how their activities have been vitalized by active research.

The Indian organisation for research is shown separately. We have taken it from the handbook of Delhi prepared by the local Committee of the Indian Science Congress.

The fundamental difference between the British and Indian systems will be at once apparent. At the head of the British organisation stand 'The Parliament', *i.e.*, the people of Britain. At the head of Indian organisation, is H. E. the Viceroy, and the H. M.'s and steps have not yet been taken that they should represent the people of India. The other grave defects of the Indian organisations have been pointed out in our editorial.

APPENDIX

Colonial Research and Development

It is only in recent years that Great Britain has given serious thought and consideration to the question of colonial research and development. Up to about the eighties of the last century, British Colonies comprised mainly Ceylon and a small part of Malaya in the eastern hemisphere, a number of trading settlements on the coasts of Africa, and in the western hemisphere, the old British possessions in the West Indies. Since then parts of Borneo, an extended area in Malaya, some of the Southern Pacific Islands and a vast area in Africa, equal to British India have been added to the British Colonial Empire.

British colonial policy was guided in the past mainly by political considerations where there was hardly any room for such thought as the promotion of the social welfare, the health and the standards of life of the colonial people. The recognition of the obligation and responsibilities on the part of the parent country towards its colonies, in the matter of social, cultural, economic and industrial development is, however, only of recent origin and has taken place through several successive stages. In conformity to this new outlook, first steps were taken towards making the colonies self-supporting. The Colonial Development Fund was instituted in 1929 to give practical shape to this idea. The Fund was authorised to spend the maximum sum of £1,000,000 on development work. The principle, then pursued when the Colonial Development Fund was created, was that a colony should have only those services which it can afford to maintain out of its own resources, and accordingly development was confined within the limits of the internal finances of each territory.

This was, however, a narrow outlook in the provision for colonial development. It was subsequently realised that in many cases colonies cannot, however, efficient their economic administration, finance out of their own resources the research and survey work, the schemes of major capital enterprise, and the expansion of administrative and technical staffs which are necessary for their full and vigorous development. This led to the formation of the West Indies Royal Commission under the Chairmanship of Lord Moyne in 1938. The present liberal and broad-based policy of colonial research and development is largely the outcome of the recommendation of this Royal Commission. According to the recommendations of the Commission, the Colonial Development Fund which was previons limited to £1,000,000 a year has now been replaced by a greater sum amounting to the maximum of £5,000,000 a year for ten years. This will be available not only for schemes involving capital expenditure for colonial development, but also for helping to meet recurrent expenditure on certain services, such as agriculture, education, health and housing.

Along with the expansion of the Development Fund, special provision has been made for research, following the proposals of Lord Hailey in his famous 'African Survey'. Hitherto, expenditure on various forms of colonial research received assistance from the Colonial Development Fund and the Colonial Office used to call upon the assistance of scientific and technical experts in dealing with colonial problems. The colonial office also set up a number of advisory committees consisting of experts, members of Parliament and men with long colonial experience to advise on these problems. To place Colonial Resarch and Development on a permanent basis the Colonial Research Advisory Committee, with Lord Hailey as its Chairman, was set up in 1940 and a separate sum of £500,000 a year was placed at its disposal to assist in the various fields of research. These special funds and provisions for colonial research and development were provided by the Colonial Development and Welfare Act passed in 1940.

Finally a brief reference may be made to the varied colonial problems in which research and investigations are imparative. The demographic information requires to be placed on a more satisfactory basis. There is now lack of vital statistics concerning the total population of colonies and as such these should be established. There should be considerable extension of land survey, with special reference to geodetic triangulation. Geological survey should also take place on a vaster scale. There is at present great need for nutrition survey in the colonies to ascertain the dietary requirements of the different colonial peoples with wide variation of social habits and peculiarities. In the field of Health and Medical survey the scope of research is, in fact, unlimited. Above all, there is now great need for intensive anthropological and socialogical studies of the colonial people. Without a proper understanding of the culture, traditions and habits of these people which these studies can alone make available, no workable development

programme can be formulated and any that may be devised in disregard of them is destined to be a failure.

Department of Scientific and Industrial Research (D. S. I. R.)

The exigencies of the war of 1914-18 evolved the Department of Scientific and Industrial Research in Great Britain on an elaborate system with a far sighted view. It may be mentioned that England at this stage was not properly industrialized, nor that technical enterprises were much encouraged, and that scientific research were more confined in the corners of the laboratories. It may be mentioned that the pioneer aviators in England were much discouraged by the Government. But the 20th century warfare demanded all these technical activities which were so much neglected before and "already the early months of the war of 1914-18 had revealed the dangers and difficulties in which Great Britain was placed through the neglect of science by industry and the absence of an adequate scientific personnel."

The Department of Scientific and Industrial Research was created by the Act of Parliament in December 1914. It was later on felt that the Department cannot function properly unless an adequate Advisory Counciel is appointed for the organisation. Mr J. A. Pease who was then the President of the Board of Education introduced a Bill in the House of Commons to appoint an Advisory Council for industrial research in Great Britain, to be specially entrusted with the supervision and encouragement of scientific research particularly in relation to industry, and much stress was laid on the training up of technical personnel. The Advisory Council of the Scientific and Industrial Research was established by Order in Council on July 18, 1915, and great credit goes to the Advisory Council which has been instrumental in increasing greatly the number of efficient British workers and for the unprecedented expansion in the application of scientific research in industry and in every phase of national life during the period of some 28 years of its existence.

The Advisory Council (S. A. C.) is composed mainly of eminent scientific men of the country like Lord Rutherford, Sir William Bragg, Prof. Fowler, Lord Rayleigh, Sir J. H. Jeans, Prof. A. V. Hill and others. The prime functions of the Advisory Council were and are to advise the Committee of Council on proposals for instituting specific researches, or for establishing or developing special institutions or departments of existing institutions, for scientific study of problems affecting particular industries and trades, and on the establishment or award of research scholarships or fellowships. The Advisory Council is also available to advise the education departments as to the supply of workers competent to undertake scientific research.

Although the Department of Scientific and Industrial Research was created during the war it was not merely an emergency organisation. The Department was planned entirely on permanent national basis, taking into account the emergent necessities of the war as well as the post-war reconstruction.

One of the most important issue was the creation of National Physical Laboratory. The N. P. L. co-ordinates the scientific and technical problems in its own laboratories or have them co-ordinated in specially controlled places, such as, universities and industrial factories or their associated laboratories and then pass on the result of the industry with its hall-mark of precision. The standardization of fundamental units of measurements has its essential bearing on the stability of industrial reproduction and in maintaining adequate specifications for the producer as well as for the consumers.

The Department has its different boards and sub-committees to deal with different problems: for instance, Fuel Committee, Radio Research Board, Iron and Steel Committee, Water and Atmospheric Pollution Research, Medical Research, Agriculture, Food Investigation Board, Textile, Aircraft, Electrical Apparatus, etc., are treated elaborately under each of these Committees.

The Department of Scientific and Industrial Research did not restrict its attention only to the works of industrial nature since it was appreciated that no technical processes or its application can be fully evolved without the proper understanding of the fundamental science—or socalled 'pure' science. "The service which the Department of Scientific and Industrial Research has rendered to the development of pure science is far from being limited to the provision of maintenance allowances for students or even special assistance to independent research workers, whether by helping young research workers of exceptional ability to pursue their work for a limited period without the necessity of finding other employment, by the provision of funds for research of technical assistants or the purchase of special apparatus and equipment, or, in special circumstances, by making really substantial grants. The Advisory Council has consistently shown in its reports a wise concern for the conditions of employment of the research worker, whether in regard to salary or security of tenure; this is a contribution to the raising standards in the last two decades which has earned the cordial appreciation of all scientific workers." (For fuller account, see SCIENCE AND CULTURE, Vol. V, p. 649).

Medical Research Council (M. R. C.)

Medical Research Council (formed in 1914) is one of the three research departments of the Privy Council. Numerous are the services rendered by the Medical Research Council with its forty-five committees and sub-committees. At present the activities of the Medical Research Council are not confined only within the domain of medicine but extend far beyond it. It is directly concerned with all the problems that affect man's health and efficiency.

The activities of the Research Council were found to be extremely satisfactory and the Committee has been allowed full scientific freedom and complete control over the funds at their disposal.

The activities of the Council are manifold. The results obtained by the Nutrition Committee are invaluable as it is well-known that nutrition in war time affect both the population as a whole under the conditions of rationing and the armed forces in respect of great use of tinned foodstuffs. It has taught the people how to make the best use of food that they can get and how to keep good health.

Another important committee is the committee of Preventive Medicine which has studied methods of immunization against diseases such as diphtheria, whooping cough, etc. and outbreak of epidemics.

Medical Research Committee is helping different authorities to select proper man to the proper place.

The activities of Medical Research Council now extend far beyond medicine. The Health of Munition Workers Committee was appointed to consider and advise on individual fatigue, hours of labour and other matters affecting the personal health and efficiency of workers in munition factories and workshop.

The M. R. C. is directly under the Lord President of the Council, and has nothing to do with the Public Health Service, which is under the Ministry of Health. In India, the two are lumped together, with no happy result, as mentioned elsewhere.

Ministry of Aircraft Production (M. A. P.)

The war of 1914-18 necessitated the formation of Department of Scientific and Industrial Research in England with a view to mobilise the scientists to war effort. Though the services rendered by the department were numerous yet it was found that the present scientific warfare requires the fullest mobilization of the scientists and co-ordination of the sister departments.

At the early stage of the war England had to face severe bombing and finding the superiority of German planes of various kinds, England felt the necessity of the formation of the Ministry of Aircraft Production.

Formerly the function of the Ministry of Aircraft Production was to expedite the production of the various kinds of aircrafts, and to speed up the production of the parts that go to build up the aircrafts. Its duty is also to look after that no factory engaged in the manufacture of aeroplane parts suffers for want of labour, material and equipment.

Soon it was realised that the war is a total and a truly scientific war and that the war would not be won merely by the physical ascendency of race but rather by the ingenuity and skill of those who have been trained in secondary schools, technical schools and universities. Mere mass production would not suffice, quality is also essential. With the view to improve the quality of planes the Aeronautical Research Committee (A. R. C.) was formed. The members of the Aeronautical Research Committee and its sub-committees were drawn from Government technical staff and non-official scientists with the necessary qualifications. From time to time the membership of these bodies is changed with the view of giving a freshness of outlook.

In addition, to this there are advisory committees consisting of engineers and scientists from whom advice is sought for a specific problem.

The workers acting under this research committee are all engaged for the developments of aircrafts. The Chairman of the Aeronautical Research Committee is also a member of the Ministry of Aircraft Production Supply Council and of Air Council thereby giving a scientific link to the Air Ministry and the Ministry of Aircraft Production.

The Aeronautical Research Department is solely engaged for developing better and varied types of aeroplanes to suit different purposes. It has no concern for manufacture.

The Ministry of Aircraft Production also has an important organisation devoted to Radio development under the Controller of Communications Equipment; though there are in addition many scientists operating outside the research sphere, both in development and production and on operational planning.

The proper distribution of planes and pilots to the field necessitated the formation of Air Council. The Ministry of Air Council keeps close touch with the military authorities and is responsible for the distribution of planes and pilots.

For the recruitments of men suitable for air force the Air Ministry has set up Flying Personnel Research Committee. This Committee works in conjunction with the Medical Research Council.

Finding that without meteorological forecasting no operation in air can be undertaken, a meteorological section was incorporated in the department. In the early part of 1942 under Air Council a Meteorological Research Committee was formed to advise and assist in the carrying out of Meteorological investigation under the Chairmanship of Professor S. Chapman, Professor of Mathematics at the Imperial College of Sciences and Technology. The Committee would welcome contact and co-operation with University Departments or other institutions engaged on work that bears on meteorology (*vide* Science and Culture, Meteorology in Peace and War, Vol. 8, p. 156).

Air Ministry has now handed over most of its research work to the Ministry of Aircraft Production for better management and co-ordination.

Army Operational Research Groups (A. O. R. G.)

Army Operational Research Groups came into existence in Great Britain in order to secure effective co-operation between the scientific and the fighting men. Today science is playing a very great role in the prosecution of war and the closest association between science and the services is a vital necessity to ensure the maximum war effort.

The practice that is usually followed is to hand over to the operational research sections the specific problems faced by the services. Sometimes the research sections may take the initiative in carrying on investigations for the solution of problems which they regard to be vital to war effort. However, the research sections have no authority to demand any specific course of action. They analyse facts, past experiences, arrive at conclusions which they hand over to the military authorities. It remains entirely with the latter to follow this advice and carry out operations in the light of advice given.

A. R. C.—Agricultural Research Council.

A. R. L.—Admiralty Research Laboratory.

D. G. R. D.—Director of Research and Development. This is in charge of Dr Gough (Engineer), head of the Engineering Department of the National Physical Laboratory. The department employs about 1,000 scientists and engineers.

O. R. G.—Operational Research Group (employs about 200 scientific men with all command groups).

S. A. C.—Scientific Advisory Council.

R. A. E.—Royal Aircraft Establishment.

Extra-mural Work—is the work done in the laboratories and workshops of universities, and other educational institutions, industrial laboratories, etc., for the war effort.

* The first President was Sir Henry Tizard, F.R.S.

AN APPRECIATION OF THE WORKS OF PROF. A. V. HILL

It is very rarely that a physicist and mathematician turns his mind to the study of problems connected with life and tries to find order and law in the chaos apparently prevailing in vital phenomena. Archibald Vivian Hill belongs to this rare class, along with Helmholtz or Nernst. A. V. Hill has always tried to probe into the mysteries of life in a direct manner. He has attempted "to include the complex and the variable phenomena presented by animal functions within the procrustean bed of mathematical formula" and has always protested that physiology is treated merely as 'the hand maiden of medicine'. He hopes that as 'in recent years the works of physicists and chemists have given us certainty that theories of atoms, molecules and stereochemistry are based on real objective fact, so it will be with physiology--though our way may be much harder and longer than those who deal with such simple things as molecules, atoms and electrons'. A. V. Hill belongs to an age which produced a gallaxy of brilliant physiologists like Sherrington, Dale, Hopkins, Heymans, Meyerhoff, Embden and Lundsgaard.

Hill's earliest work dates from 1910, when in his "new mathematical treatment of changes in ionic concentration in muscles and nerves, under the action of electric current, with a theory as to their mode of excitation" (*Journal of Physiology*, Vol. 40), he elaborates and improves on Nernst classical theory of excitation of nerves.

Soon A. V. Hill interested himself in the study of output of heat by resting and by working tissues. Fletcher in 1902 and Fletcher and Hopkins in 1907 had established that the actual contractible process in muscle is not associated with consumption of O_2 or giving out of CO_2 but that the only demonstrable change was appearance of lactic acid—the accumulation of which leads to fatigue and the oxidative removal of which means recovery. Hill improved the technique of recording minute changes in heat production by contracting muscle and began to study in detail the heat output during anaerobic contractions and aerobic recovery. He established that there is a direct relationship between tension developed and heat given out, that the heat output or tension developed is proportional to the initial length of the muscle fibre and not to its volume and independent of the rate of stimulation. He calculated the mechanical potential energy to be ⅙ Tl (Tension-Length) which may be wholly available for being turned to external work. That is, the theoretical mechanical efficiency should be 100 per cent but was reduced in two ways *viz.*, (*a*) loss of energy due to frictional causes—a contracting muscle being a viscous elastic system and (*b*) loss of energy in the subsequent recovery process. Later on, he concerned himself with elucidations of time relations of events in muscular contraction, by a study of the sequence of thermal changes during excitation of muscle in absence of oxygen and of thermal changes during the subsequent oxidative recovery period. All these observations were possible on account of the construction, with the help of Hartree and Downing of a very delicate thermopile which can record changes of temperature of the order of $2{\cdot}5\ 10^{-8}$°C.

A. V. Hill's work in connection with viscous elastic properties of muscles has already been alluded to his critical examination of the Fenn effect is another notable contribution. He demonstrated that the Fenn effect is found not under all modes of stimulation but depends on the original length of muscle and work done.

Adventures of A. V. Hill in various aspects of biophysics are too numerous to refer to in the article. He was the first to explain vapour pressure changes and osmotic pressure changes in muscles during activity. This v.p. changes in muscles not only leads to concentration of body fluids but is of such magnitude as to indicate an increase of 50 per cent in number of osmotically active substances in the muscle, which cannot be adequately explained in terms of the known chemical changes associated with muscular activity. Hill is therefore again in a position to prophesy that unknown reactions of considerable magnitude must be taking place in muscle during activity and must be searched for. Other interesting sojourns was the study of the steady state in muscular exercise and the state of water in tissues.

Last but not the least is A. V. Hill's contribution to the problems of nerve physiology including heat output by resting and active nerves, with the help of a still further improved thermopile which is doubly as delicate as the previous one. Action potentials of active nerves are according to Hill, due to discharge of a dielectric across a polarised surface film of the nerve fibre and the action current is itself associated with the mechanism of transmission of nerve impulse. The active element in a nerve fibre is a monomolecular film maintained in the resting polarised state with potassium ions inside and anions outside at the expense of oxidative reactions of rest. Stimulation means momentary depolarisation due to increased permeability—a discharge of electricity from in—outwards, associated with movements of potassium ions. Thus electrical excitation of nerves and electrical basis of nerve impulse transmission are put on the basis of chemical action—the socalled "chemical wave transmission in nerves".

S. Banerjee

THE THIRTY-FIRST SESSION OF THE INDIAN SCIENCE CONGRESS

THE Indian Science Congress held its thirty-first Session in the metropolis of India on January 3—6, 1944, and from all accounts, it appears to have been a grand success. The Session is memorable in many respects ; for this was the first Session of the Indian Science Congress held at Delhi, which city, though the metropolis of India since 1912, has not so far ranked high in the estimation of the scientists of India as a possible venue of the Indian Science Congress during the last thirty one years. But within the last ten years, Delhi as a scientific centre has grown rapidly, thanks to the transference of the Imperial Agricultural Research Institute (originally established at Pusa, Bihar in 1905), the Board of Scientific and Industrial Research (1940), Malaria Institute of India, the Upper Air Observatory (Agra) Office and the Central Revenues Control Laboratory. The offices of the Indian Research Fund Association, the Imperial Council of Agricultural Research and the All-India Radio and the office and the museum of the Archaeological Survey of India have been there already. The non-official element in scientific talents at Delhi is still very weak, being represented only by the professors of the University of Delhi, and of its constituent colleges, but due to the energetic action of the present Vice-Chancellor, these elements are being steadily strengthened, and let us hope that when the Science Congress holds its next Session at the capital city, it would show as strong a non-official group of scientists as any other older centre of education in India.

Besides the members from different parts of India, the Congress was attended by many members of the Viceroy's Cabinet and important citizens of Delhi. Much credit is due to Sir Maurice Gwyer, the Vice-Chancellor of the University, and other university authorities particularly those of the St. Stephen's College for agreeing to accommodate the Indian Science Congress at such short notice.* The success of the Session was due to the untiring efforts of the local secretaries, Sir S. S. Bhatnagar and Prof. D. S. Kothari, ably assisted by an energetic band of volunteers. It was pointed out that this was the fourth occasion that Sir S. S. Bhatnagar piloted the Indian Science Congress as local secretary (Benares 1923, Lahore 1927 and 1939, Delhi 1944), and it was only befitting that in recognition to his services to the Indian Science Congress, his eminence as a scientist, and his services as an organiser of Scientific Research that he should be elected as the General President of the next Session of the Congress to be held at Nagpur.

* The Congress was to be held at Trivandrum but the programme was upset at the last moment due to transport difficulties.

Sir Maurice Gwyer, Chairman of the Reception Committee, in delivering his welcome address, said :

"The conflict which was once supposed to exist between science and humanism is for all wise men at an end; and indeed if the aim of both is, as it must be, the spread of learning and the establishment of truth, it is strange that there should ever have been any question of rivalry between them. Each learns something from the other, each makes the other more fruitful; and from this happy union may a new generation arise, reflecting the beauty and vigour of both its parents.

Indian science has already achieved a position second to none in the world, and Indian men of science have it in their power to make a contribution to the future welfare of India almost beyond human computation. They can transform the face of India, 'hey can multiply its wealth, they can solve the problems of ignorance and poverty; and who knows whether they may not even be able to solve the most intractable of all, India's constitutional problem? It is the earnest prayer of all who have the happiness and welfare of this country at heart that all these problems, surveyed in the calm and serene atmosphere of science by men consecrated to the search for truth and nothing but the truth, with minds free from prejudice or bias, may find a solution, or at least the beginnings of a solution, at the meetings this week in Delhi.

By the irony of circumstances, war, that great enemy of human progress, affords the most powerful stimulus to scientific research that we know; but good can come out of evil, as war is followed by peace; and that part of the world which still loves peace and still believes in human personality in the dignity of man and in honest dealing between nation and nation, will benefit hereafter from the labours of scientists to put new and ever more potent weapons in its hands to defeat the enemies of mankind. For those and for the many other blessings which, by the goodness and mercy of God, men of science have bestowed upon us, we tender them our gratitude; and we hope that their labours this week and the discussions and contacts which a gathering like this makes possible will bear fruit a hundred-fold."

Just before the Congress formally started, the gathering was temporarily converted to a meeting of the Royal Society of London, and Prof. A. V. Hill, Secretary of the Royal Society, who has come out to India on a tour of goodwill mission, on whom the authority of a Vice-President of the Royal Society was conferred, performed the pleasant function of admitting two newly elected Indian Fellows, Sir S. S. Bhatnagar, and Prof. H. J. Bhabha, formally to the Royal Society.

The Session was then formally opened* by H. E. Viscount Wavell, Viceroy of India, with the following speech :

"India, one of the oldest civilisations, has perhaps felt the impact of modern science later and less than any other great people. A large proportion of her population still lives the old life untouched by the vast changes of this century. Her realm has been of the spirit rather than of the earth. It may be said of the West hereafter that we took too much from India materially and too little spiritually.

But if India is to play the part in the world to which her size, her population, her history and her position entitle her, she too must make every possible use of scientific advancement. She has already produced many great scientists, she bears many more in her fertile womb. Her contributions to science have always been on the side of peace and progress. She was everything to gain by combining modern science with her old culture, her traditional outlook should enable her to make an increasingly fine and characteristic contribution to natural knowledge. Indian science has, in fact, made a very remarkable stride forward during the last 25 years, as is shown by the foundation of many new societies, new journals and new departments of science in Universities and under Government.

In this war science has played a great role in India as elsewhere. It has made a splendid contribution to maintaining the health of the fighting men, through the activities of such bodies as the Malaria Institute, the Indian Research Fund Association, the Nutrition Laboratories at Coonoor, and others. It has also played an important part in munitions production and in solving problems of supply. As a ex-Commander-in-Chief, I should like to thank Indian science for the invaluable assistance it has given to the armies in the field.

It must play a great part also in post-war development. The coming years will be vital to India. She must learn to make use of her abundant resources with the aid of science, which is the most international of all human interests. Professor Hill has himself said in an address elsewhere : 'I believe that the pursuit of knowledge for the welfare of mankind is one of the greatest agents for goodwill between men in every land.' It is in that belief that he is here to-day.

This session of the Indian Science Congress has a momentous task to perform; to discover how best to bring the aid of science to the development of India's great resources in agriculture and industry, to the improvement of health and to social advancement and prosperity. This Science Congress is a body of high repute, with a great and growing membership and influence. Gentlemen, I wish all success to your deliberations.

Prof. S. K. Mitra, General Secretary of the Science Congress in thanking the Viceroy said :

We are extremely grateful to His Excellency the Viceroy for coming here this morning to open the proceedings of the Thirty-first Session of the Indian Science Congress. It has been customary in all ages and in all countries for the royalty and the wealthier section of the community to be the patrons of arts, science and learning. It is therefore but proper and natural that His Excellency, as representative of His Majesty the King Emperor, should come here to inaugurate our Proceedings. We would, however, love to think that His Excellency is in our midst today, not as a matter of duty—because he represents the Crown—but because he is a soldier and he thinks the scientists as his comrades-in-arms, who have helped him in fighting the Axis powers abroad, and who would now help him in fighting the *Axis* combination within the country—the combination of Poverty, Ignorance and Disease. Ladies and gentlemen, His Excellency has already, some time ago, referred to the urgency of fighting and exterminating this combination. On the eve of his departure from England, His Excellency said at the Pilgrims luncheon : "It has always seemed to me a curious fact that money is forthcoming in any quantity for the war, but that no nation has ever yet produced money on the same scale to fight the evils of peace—poverty, lack of education, unemployment and ill-health. When we are prepared to spend to this end, our money and our efforts as freely and with the same spirit as against Hitler, we shall really be making progress. In the country to which I go, these evils of poverty, lack of education and disease have to be met on possibly a greater scale than any where else. Ladies and Gentlemen, in the name of the Indian Science Congress Association, which is a representative body of scientific workers in India, I can assure His Excellency, that the scientists of this country, are always eager to lend their fullest support to his efforts in fighting these evils which act and react on each other in a vicious circle in this ancient and unfortunate land of ours. Ladies and gentlemen, will you now kindly join me in very sincerely and heartily thanking our soldier and fighter Viceroy for his interest in the Indian Science Congress and for the trouble he has taken, in spite of his multifarious duties, to come over here to open our proceedings.

The following messages of welcome were received from the Rt. Hon'ble Mr Winston Churchill and Field-Marshal Smuts respectively through Prof. Hill.

(1) "I am very glad to have the opportunity to send through you my greetings and good wishes to Indian men of science and especially to the six Indian Fellows of the Royal Society, of which I am honoured to be myself a Fellow.

"It is the great tragedy of our time that the fruits of science should by a monstrous perversion have been turned on so vast a scale to evil ends. But that is no fault of science. Science has given to this generation the means of unlimited disaster or of unlimited progress. There will remain the greater task of directing knowledge lastingly towards the purposes of peace and human good. In this task the scientists of the world, united by the bond of a single purpose which overrides all bounds of race and language, can play a leading and inspiring part."

(2) "I am much interested to hear of your coming mission to India, and feel certain that you will be able while there to place your large and varied scientific experience at the disposal of the Government and other organisations in all matters in which science plays a part. There as elsewhere scientific research in relation to industry, agriculture, war and in other directions is of paramount importance, and you will find a rich field for your knowledge and energy.

I am specially interested to know that you will probably attend a meeting of the Indian Science Congress, and will also act on behalf of the President of the Royal Society in admitting to the Fellowship of the Society a number of distinguished Indian scientists. As a past President of the parent British Association for the advancement of Science, and a senior Fellow of the Royal Society I should like to express through you my congratulations and cordial good wishes to these gentlemen on their becoming members of the greatest and most famous scientific society in the world.

* It has been a general custom that the Indian Science Congress is formally opened by the Viceroy, whenever available, or in his absence by the Governor of the Province or ruler of the State in which the Congress is held.

In the great forward movement of India in our day, which is so universally acclaimed, there is nothing more outstanding than the part her sons are taking in science and scientific research, and some of the most notable advances in physics, mathematics and the biological sciences have come from Indian workers. Among them the names of our Indian F.R.S.s—Raman, Saha, Sahni, Krishnan, Bhabha and Bhatnagar are known over the whole world of science and have added lustre to India even outside the domain of science. It is therefore fitting that your scientific mission of goodwill should also be the occasion of honouring these scientific sons of India and conveying to them the congratulations of the whole scientific world."

A number of public lectures, and symposia were arranged, list of which is given in the appendix. The public lecture which excited the greatest interest was the one delivered by Prof. A. V. Hill, F.R.S. on 5th of January, 1944. The lecture is reproduced elsewhere in this issue with our editorial comments.

The Science Congress week affords an opportunity for scientists for all parts of India to assemble at one place for one week, to exchange views and establish personal contacts. It is also the occasion for all the important learned societies to hold their annual functions. A list of such functions which were held at Delhi is given in the appendix. Full members and Session members attended the Congress and inspite of transport difficulties from which Delhi suffers, the local authorities spared no pains in arranging for excursions and providing other social amenities.

The National Institute of Sciences, the premier learned body of senior scientists in India, held its annual session at Delhi on the 29th and the 30th December 1943, under the presidency of Sir J. C. Ghosh, and held a symposium on the proposed National Research Council for India. The symposium was attended by 55 Fellows, and 35 representatives of learned bodies from all parts of India. The National Institute of Sciences passed a series of important resolutions on the Aims and Objectives of a National Research Council of India, on its constitution and on the formation of research committees and recommended that, following the practice in the United Kingdom, one per cent of the national budget should be set apart for scientific research. We also understand that the authorities of the National Institute of Sciences are in correspondence with the Government of India regarding the acceptance of these resolutions.

Some of the presidential addresses delivered in the sections will be published in our subsequent issues as the space permits.

APPENDIX

1. Titles of Addresses of Sectional Presidents:
   - *Mathematics & Statistics*—'Fundamental Equations of Quntum Mechanics,' by Prof B. M. Sen.
   - *Physics*—'Cold Dense Matter,' by Dr D. S. Kothari.
   - *Chemistry*—'Some Aspects of Modern Inorganic Chemistry,' by Prof R. C. Ray.
   - *Geology & Geography*—'The Bombay Island', by Dr A. S. Kalapesi.
   - *Botany*—'Progress of Botany with Special Reference to Economic Plants,' by Dr T. S. Sabnis.
   - *Zoology & Entomology*—'The Golgi Apparatus', by Prof. Vishwa Nath.
   - *Anthropology & Archaeology*—'Truth in Anthropology,' by Mr Verrier Elwin.
   - *Medical & Veterinary Sciences*—'Medical Education,' by Prof. K. V. Krishnan.
   - *Agricultural Sciences*—'Some Aspect of the Present and Post-War Food Production in India,' by Rao Bahadur D. V. Bal.
   - *Physiology* 'Harmony and Rhythm in Nature,' by Prof S. N. Mathur.
   - *Psychology & Educational Sciences*—'The Practical Aspects of Educational Reconstruction in India,' by Mr John Sargent.
   - *Engineering & Metallurgy*—'Industrial Research,' by Mr J. J. Ghandy.

2. The following discussions were held in the various sections:
   - (*a*) Food Economics.
   - (*b*) Ethnology in Indian Museums.
   - (*c*) The Manufacture of Photographic materials in India.
   - (*d*) Mental life as pictured in contemporary psychology.
   - (*e*) Locusts and the species problem.
   - (*f*) Science and Practice of Soil tillage in India.
   - (*g*) Biological assay of drugs in India.
   - (*h*) Electro-Chemical Industries.
   - (*i*) Correlation of Stone Age Culture of India.
   - (*j*) Achievement Tests and Accomplishment quotient on their educational applications.
   - (*k*) Zoology and the Food Problem.
   - (*l*) Methods for the Improvement of Yields of Paddy in India.
   - (*m*) Insecticides.
   - (*n*) Standardisation of certain terms in Indian Geology.
   - (*o*) Position of Physiology as an independent Science.
   - (*p*) The need of Eugenical studies in India.

3. The following learned societies held meetings as follows:
   - (*a*) Annual Meeting of the Society of Biological Chemists, India.
   - (*b*) Annual Meeting of the Indian Physical Society.
   - (*c*) Annual Meeting of the Indian Psychological Association.
   - (*d*) Annual Meeting of the Physiological Society of India.
   - (*e*) Annual Meeting of the Entomological Society of India.
   - (*f*) Annual Meeting of the Indian Botanical Society.
   - (*g*) Annual General Meeting of the Indian Pharmaceuto Association.
   - (*h*) Annual Meeting of the Indian Society of Soil Science.
   - (*i*) Annual Meeting of the Institute of Chemistry of Great Britain and Ireland (Indian Section).
   - (*j*) Meeting of the Indian Ecological Society.
   - (*k*) Annual Meeting of the Indian Chemical Society.
   - (*l*) Conference on Food and Nutrition under the auspices of the All-India Nutrition Board.

4. Popular lectures were delivered on the following subjects:
   - (*a*) Architectural Education in India.
   - (*b*) The Scientific Organisations—Official and Non-official—in the United Kingdom.
   - (*c*) Food and the Food Crisis.

5. There was a symposium on 'Place of Science in the Indian Educational System' under the auspices of the 'Sub-Committee on Science and its Social Relations'.

6. A special broadcast talk was given by Prof S. K. Mitra, General Secretary of the Indian Science Progress Association, on 'Indian Science Congress—its forthcoming session from Delhi station on 2nd January, 1944.

STATE CONTROL AND ORGANISATION OF THE MISSISSIPPI RIVER BASIN

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THE drainage basin of the Mississippi comprises 1,240,000 sq. miles (which is some 16 times the area of Bengal) and includes more than 40 per cent of the total area of U. S. A. About 13,000 sq. miles of the above total drainage basin cover two Canadian Provinces. The very existence and well-being of a considerable part of U. S. A. depend, therefore, largely upon the proper maintenance of the river-system. Although some general studies of the rivers were made in the earlier part of the last century, and earlier still, it is since 1861 that more thorough and systematic investigations were undertaken by the Mississippi Engineers. In those days attentions were paid on the regular survey of the rivers, with special reference to their discharge rates, methods of levee (embankment) construction, bank protection, effect of training works, change of river course, etc.

The entire drainage system of the Mississippi and its tributaries embraces six great natural divisions as detailed in Table I. (See also the map annexed, fig. 1).

TABLE I

SIX DIVISIONS OF THE MISSISSIPPI BASINS

Drainage systems of the Mississippi.	Percentage of total basin area	Slope (ft. per mile)	Flood Section (in thousand sq. ft.)	Max. discharge (cusecs)	Min. discharge (cusecs)
Ohio Basin ...	16	0·44	150 to 200	1,233,000	42,000
Upper Mississippi Basin ...	13	0·59	100	337,000	25,000
Missouri Basin ...	43	0·97	75	370,000	19,000
Arkansas Basin ...	15	0·62	50	460,000	4,000
Red River Basin ...	7	...	...	228,000	4,000
Central Valley ...	6	0·35	...	373,000 At St. Fransis*	

It may be mentioned that though the Missouri-Mississippi is a very long river (4250 miles) compared to the Ganges-Brahmaputra system (Ganges 1550 miles, Brahmaputra 1800 miles) the total amount of water discharged by the Ganges-Brahmaputra system is far larger than that of the Missouri-Mississippi. The maximum flood discharge of the Ganges near Sarah (before the confluence with the Brahmaputra) is 2 million cusecs,* and the minimum is about 50,000 cusecs. These figures are almost equal to that of the Mississippi near its mouth. The discharge of the Brahmaputra has not been measured but it is probably fifty per cent higher than that of the Ganges. The total water carried by the Ganges-Brahmaputra system (4 to 5 million cusecs) into the Meghna, therefore, exceeds that of the Mississippi system at its mouth which is some 2,850,000 cusecs.

EARLIER MAPS AND SURVEYS OF THE MISSISSIPPI BASIN

The history of the discovery of the Mississippi river by the people of the old world dates to the voyage of Columbus. The "Admiral's Map" in the Royal Library at Madrid furnishes the evidence that the mouths of the river were seen by Columbus in his fourth voyage which he launched from Spain in March, 1502. The map appears to have been engraved in 1507.

More detailed voyage through the interior of the river and its tributaries was undertaken by the Spanish party headed by Hernando de Soto in 1539, and that is why De Soto is commonly believed to be the discoverer of the river. De Soto died on April 17, 1542 of malaria when they reached the confluence of the Red River. His party, however, continued the expedition up to the mouth of the Arkansas River and came down and settled at Tampico.

Garciliaso de la Vega in his history of De Soto's expedition described a heavy flood of the Mississippi below the confluence of the Arkansas River, which the Spaniards witnessed. The flood began on 10th March, 1543 and cresting about 40 days later. By the end of May the river had returned within its banks, having been in flood for approximately 80 days.

* A very high flood discharge of 580,000 cusecs was recorded at this station in 1897. (*cusec*='cubic feet per second').

* A maximum of 2¼ million cusecs was recorded in 1910.

After De Soto's voyage the Spaniards apparently lost interest in the Mississippi expedition, when the French made further systematic survey. Radisson and his brother-in-law Croseilliers explored in 1655-56 near what is now known as Prairie Island. Joliet and Marquette were deputed by the Governor at Quibeck, to survey the mouth of the great river for the expansion of his territory. Their expedition was conducted between May 17 and July 17, 1673. In August 1678, La Salle set out from Lake Michigan, thence down the Illinois River. On February 6, 1682 the Mississippi River was reached, and two months later, on April 6, they reached the Gulf of Mexico.

The credit of the discovery of the Lake Itasca, the source of the Mississippi River, goes to Mr Henry R. Schoolcraft who discovered it in July 13, 1832.

Among the earlier maps, those prepared by Lieut. Ross (1765), Capt. Philip Pitman (1768) and Gen. Victor Collot (1796) are extremely valuable. Maps, however, were drawn still earlier by De Lisle (1718), and Marquette's map is probably the first one (1673) ever made which extended from Mackinaw to the mouth of the Arkansas River.

Another map, now preserved at the office of the President, Mississippi River Commission, at Vicksburg, was drawn by one Mr William Wilton in 1774, covering a part of the Mississippi from Manchac to the River Yazoo.

The use of water level gauges on the Mississippi dates back to 1798 when the first gauge was established at Natchez by the Governor Winthrop Sargent.

The history of building levees or protection embankments on the Mississippi may be traced early in eighteenth century with the first settlement on the the lower Mississippi valley. The engineers built up by 1727, levee or dyke of length 5,400 ft. in front of the city of New Orleans which has a very low elevation and is liable to overflooding.* The dykes were extended with the settlements, and each planter was required to complete the levee along his own river front. By 1735 the levee line extended along both banks of the river for a distance of 30 miles above the city and 12 miles below. By 1844 the levee ran, on the right bank, from 12 miles below the city of New Orieans up to the mouth of Arakansas River, which means a length of about 300 miles. On the left bank the levee ran up to Baton Rouge.

By 1820 the period of discovery and settlement had come to a close. The Mississippi River was now entirely within the territorial limits of the United States. The lower valley was comparatively well settled especially in its southern areas. A levee system for the control of its floods had definitely begun. River commerce flourished, with a consequent need for navigation improvement. National attention was directed to the river.

Mississippi problems taken up by U. S. Government

The Federal Government of the States was interested in the wide system of waterways of the country and took up, for the first time, the navigation problems in the Mississippi in 1820. In this year the Congress appropriated a sum of 5,000 dollars for the preparation of maps, and other preliminery survey of the Mississippi and Ohio rivers. Navigation improvements was first authorised by the Act of Congress in 1824 when the sum of 75,000 dollars were given for the removal of snags* in the Mississippi river below the mouth of the Missouri, and in the Ohio river below Pittsburgh. This and later appropriations for navigation improvements were expended under the direction of the Chief of Engineers, U. S. Army. In 1837 the improvement of the mouth of the Mississippi for the sea-going vessels was undertaken by Congress.

About the middle of the last century the problems of the river, harbour and navigation were perceived to be of deep scientific nature, so that engineers and scientists were recruited for the purpose. In 1843 Professor J. L. Riddell began experiments on the problems of silt carried by river streams. In 1840 Lieut. R. A. Marr of the U. S. Navy, performed series of sediment observations on the Mississippi River near Memphis.

Although the U. S. Government was at first interested only in navigation problems of the country, they felt that the question of flood control is also of great national interest and is an allied problem. The flood havocs of 1849 and 1850 lead to the Swamp Acts. "By the Swamp Acts of 1849 and 1850, the National Congress granted to the several states all unsold swamp and overflowed lands within their limits. Under the provisions of the Acts, funds accruing from the sale of these lands by the states were to be applied to the prosecution of drainage, reclamation, and flood control projects. Louisiana Mississippi, Arkansas, and Missouri organised offices for the sale of these swamp lands and appointed com-

* The condition of New Orleans may be compared to that of Holland, and to any low-lying country of the Lower Bengal. The sewage of such countries has to face great difficulties. The water of the drainage system and that of rain cannot be led out by the natural slope of the country so that these have got to be pumped out into any adjacent stream. Calcutta is also faced with similar problem.

* These are trees and branches of various size, carried down the river by its flood. They are sometimes as large as 30—40 feet with colossal roots spreading some 20 -30 feet. Sometimes they anchor themselves so firmly that they have got to be sawed out or blown up by small dynamite charges They are removed by specially designed snag boats.

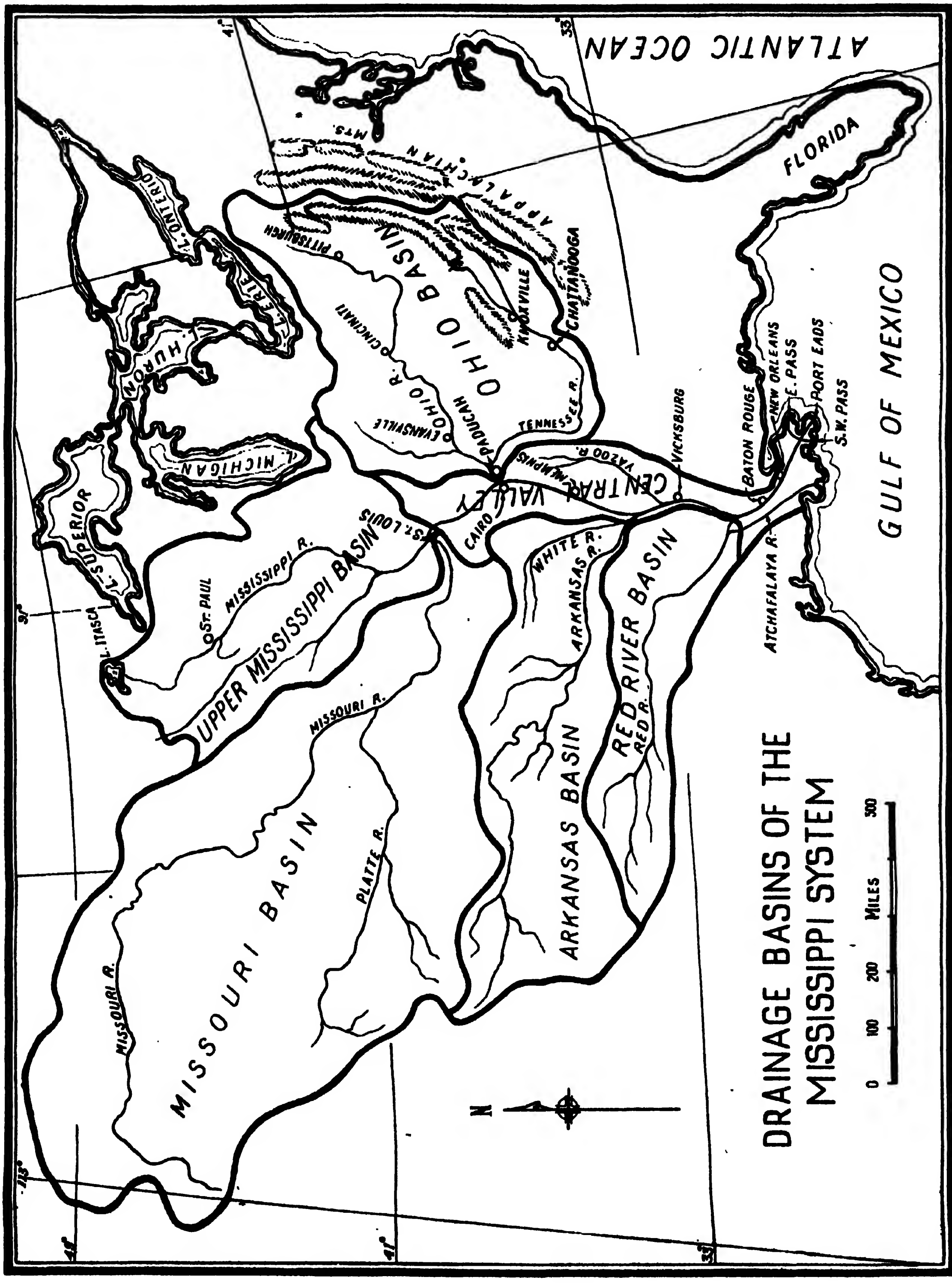

FIG. 1. Six divisions of the Mississippi system.

missioners for the construction of levees. As might have been expected, however, this attempt to secure effective flood protection failed due primarily to the lack of co-ordination among the different states and districts. Within the few years following 1850 some effort was made to secure necessary co-ordination by the passage of laws standardizing levee construction."[3] (p. 8)

In 1850 the Secretary of War directed Mr Charles Ellet, Jr., an engineer, to make surveys of the rivers Mississippi and Ohio so that a proper method of flood control may be planned. About the same time Capt. A. A. Humphreys of the Corps of Engineers, and Lieut. Henry L. Abbot made a detailed survey of the lower reaches and prepared the Report on the Delta Survey. A sum of 50,000 dollars was granted for the Delta Survey and the final Report was submitted in 1861 and is published under the name "Report upon the Physics and Hydraulics of the Mississippi River ; Upon the protection of the Alluvial Region against overflow and upon the Deepening of the Mouths".

Although studies have been made on the river and its floods, no very satisfactory gauges in adequate number were found to exist for accurate recording of the floods or low water conditions. The Resolution of Congress dated February 21, 1871, directed the Secretary of War to establish gauge stations at important points on the river and its tributaries.

The disturbances of the Civil War practically stopped the activities of the river training works between 1860 and 1867. There was, therefore, great damages on the levees in the floods of 1862 and 1865, which remained unattended. The flood of 1874 caused considerable damage on the levee system in the low valley, and as a result, a board of engineers known as "Levee Commission" was directed to examine the system and to submit a plan for the reclamation of the Alluvial Valley.

The lowest reaches of the Mississippi near the Gulf, offered great problem of maintaining the depth of channel for the vessels. The River and Harbour Act of March 3, 1875 authorized Mr James B. Eads and his associates to build jetties and other works in the South Pass for the purpose of obtaining and maintaining a ship channel. Mr. Eads worked with great success and they built the Port Eads at the mouth of the Mississippi on the Gulf.

The Mississippi River Commission

The Mississippi River Commission was organised in 1879. The Commission provides funds for systematic survey of the rivers in order to collect physical data for developing river training methods on scientific basis. "The final object of the expenditure and their investigations is the improvement of the low water channels of the river and the protection of the country from flood."

As the river and its tributaries flow through more than one state or province, the task of training them cannot, obviously, be laid on a single State. It is therefore a joint concern of the individual states as well as of the Central Government the Congress. It will thus be seen that there exists a sort of dual control over the river training organisation. "The Commission are practically the advisers both of Congress and of the local States, though they have no control over the expenditure of the latter. It is however, said that all concerned work together most harmoniously for the common good . . . .

"The Commission consists of three officers of U. S. Corps of Engineers, two Civil Engineers, one Officer Coast Survey, and one representative of the legal profession, with an officer of the Corps of Engineers as Secretary. The office of the President of the Commission is in New York, but that of the Secretary is in St. Louis. (The head quarters of the Mississippi River Commission have been shifted to Vicksburg since 1928). In addition to his Commission duties the Secretary has the management of discharge observations and dredging, as well as the direction of the survey operations. The President of the Commission is the senior member belonging to the Corps of Engineers."[1] (Notes on the Mississippi, F. W. Wawson.)*

Widening the Scope of the Mississippi River Commission.

Prior to 1881 the jurisdiction of the Mississippi River Commission was restricted to the lower basin of the river. The River and Harbour Act of March 3, 1881 provided for extention of the Commission's operations and jurisdiction to the tributaries for the perfection of the general and permanent improvement of the river. Then, the year 1882 is also significant as marking the beginning of the levee work by the Commission.

More and more responsibility was given in the hands of the Commission as it was operating in a very effective manner. The floods of 1897, 1912 and

* Mr F. W. Dawson was the Executive Engineer, Bombay, on special duty. In the preface of the volume he writes "The notes were prepared by the writer while on special duty on the Mississippi River for a period of six months under the orders of the Government of Bombay, the object of his deputation being to study the practice of the Mississippi Engineers with a view to recommending the adoption of such of their methods of scientific research and engineering principles as might be suitable to the Indus River.

1913 called for special attention regarding the methods of flood control. In the year 1914 concrete revetment was tried under the Commission and proved to be extremely efficacious though very costly. The River and Harbour Act of July 27, 1916 entrusted the Mississippi Commission with the control of the Ohio river for about a length of 100 miles.

It was, however, gradually appreciated that the jurisdiction of the Mississippi Commission should be wider enough to cope with the problems, the roots of which are seated in the extensive reaches of the entire basin. Consequently, the socalled Flood Control Acts (1917, 1923) widened the jurisdiction of the Commission to almost boundless extent, for, we read in the Report of the President, Mississippi River Commission, "The Act of March 4, 1923, stated that the Commission jurisdiction for flood control work extended from the Head of the Passes to Rock Island, and up the tributaries and outlets of the Mississippi River so far as they might be affected by Mississippi River flood waters".[2] (p. 19)

"The present flood control operations include the establishment of a hydraulic laboratory. This laboratory known as the *Waterways Experiment Station*, is situated at Vicksburg under the direct supervision of the office of the President of the Mississippi River Commission. Here experiments and studies are carried on. The solution of river problems by the use of models is undertaken on a large scale. The establishment of the laboratory does, however, provide for the systematic and continuous prosecution of such work and insures the preservation and proper evaluation of results"[3] (p. 21). The Waterways Experiment Station covers an area of some 250 acres where the physics and engineering of the Mississippi River is elaborately studied in order to evolve methods of flood control, navigation, irrigation, etc. There are dozens of such hydraulic laboratories in U. S. A. to look after their rivers which are the great assets of the country.

Other River Organisations

The different parts of the river and its tributaries have been put in charge of relevent bodies, for instance, "From Port Eads to the head of the Passes the river works are in charge of an officer of the Corps of U. S. Engineers, directly responsible to the Chief of Engineers, U. S. Army. From the head of the Passes to Cairo, a length of 1,060 miles, the expenditure of appropriations granted by Congress is under the control of the Mississippi Commission, who are responsible to the Chief of Engineers for the conservation of this length of the river, known as the Lower Mississippi. From Cairo to the mouth of the Missouri River constitutes a separate charge held by an officer of the U. S. Corps, under the Chief of Engineers, the present incumbent, Major Handbury, being also a member of the Mississippi and of the Missouri Commissions. The Missouri is managed by a separate Commission. The other tributaries are held as separate districts by officers of the Corps of Engineers directly under the Chief of Engineers."[1]

Though not included in the Mississippi system, the Colorado River Commission in California is responsible for taming the river and for the construction of world's largest the Boulder Dam.

Some of the Record Floods in the Mississippi

The following table shows the flood discharges recorded in several years.

TABLE II

Flood Discharges in the Mississippi between St. Louis and Columbus

Year	Mississippi discharge at St. Louis (cusecs)	Ohio discharge into Mississippi (cusecs)	Mississippi observed at Columbus (cusecs)
1897	283,000	1,240,000	1,462,000
1903	377,000	1,016,000	1,483,000
1912	592,000	1,110,000	2,015,000
1913	323,000	1,395,000	2,015,000
1922	311,000	1,137,000	1,501,000
1927	800,000	814,000	1,728,000

The flood of 1927 was extremely devastating when two major flood waves preceded the maximum wave from Cairo to Carrollton. In the States of Kentucky, Tennessee, and the northwestern part of Alabama precipitation averaging 9 to 11 inches was experienced during the month of December, 1926. This excessive rainfall caused a maximum stage of 26·1 feet and a discharge of 413,000 cusecs in the Tennessee River at Florence, Ala (a distance of 256 miles above the mouth) and a stage of 56·1 feet and a discharge of 235,000 cusecs on January 1, 1927, in Cumberland River at Nashville, Tenn. (193 miles from its mouth). Rapid rises in all Arkansas streams and in the Yazoo River also ensued as a result of the heavy December rains in Arkansas and north-western Mississippi.

In the Lower Mississippi Valley 18,268,780 acres or about 30,500 sq. miles of land were completely flooded. Over 800,000 people were driven from their homes, 313 lives were lost, and the total damage to

properties was estimated to be 60 million pounds or some 90 crores of rupees.

TABLE III

FLOOD DISCHARGES OF THE LOWER MISSISSIPPI IN 1927, AND THE MAXIMUM PROBABLE FLOOD ANTICIPATED IN THE FLOOD CONTROL PROJECT—ACT OF MAY 15, 1928.

Station	Food Discharge (cusecs)	Max. Probable Flood (cusecs)
Cairo	1,800,000	2,250,000 to 2,400,000 (a)
Helena	1,698,000	...
Arkansas City ...	2,472,000	2,850,000 (b)
Vicksburg	2,278,000	...
Red River Ldg. ...	1,779,000 (e)	1,500,000 (c)
Carrollton	1,730,000	1,250,000 (d)

Notes : (a) Birds Point New Madrid floodway wille carry 450,000 cusecs of this discharge.
(b) Of this aggregate discharge, from 900,000 to 1,250,000 cusecs will be carried down the Boeuf floodway.
(c) In addition to this discharge down the main river channel 1,500,000 cusecs will be carried down the Atchafalaya floodway.
(d) In addition to the discharge past Carrollton, the Bonnet Carre' floodway (above Carrollton) will carry 250,000 cusecs.
(e) Does not include discharge down Atchafalaya River.

METHODS RECOMMENDED FOR RIVER TRAINING

In 1931 a review on the flood control of the Mississippi was prepared by the Chief Engineer, War Department, U. S. A., in collaboration with all authorities which come under his direction, which consist of the division engineer, Lower Mississippi valley division, assisted by his district engineers ; the Mississippi River Commission ; and finally the Board of Engineers for Rivers and Harbours. Other bodies including the U. S. Agricultural Department also co-operated. This report containing technical data and costing on the projects, etc. was submitted to the Committee on Flood Control of the House of Representatives of the Congress.

The main lines of recommendations of the various bodies may be summarised as follows :

1. *Levees or Protection embankments.*—Although the protection embankments are essential for keeping the flood waters in bound in its main course, their efficacy is limited. The report of the Board of Engineers for Rivers and Harbours notes "Levees high enough and strong enough for this purpose (flood control) would be impracticable from an engineering standpoint, would be prohibitive in cost, and would greatly increase the flood hazard."[2] (p. 25).

As we have reviewed in its history, the embankment system is very old so that their maintenance or some new constructions are comparatively easy.* Levees of compromising dimensions, along with other methods of river training, have been generally recommended.

2. *Floodways and spillways.*—Leveed channels to lead off excess flood waters are effective to reduce the thrust of flood. This would effectively include canal system for irrigation.

3. *Reservoirs.*—"This method of flood control was considered at great length in the preparation of the original report. The whole Mississippi watershed was studied. It was found that a system of reservoirs could be built on the headwaters of the tributaries of the Mississippi which would make substantial reductions in the flood heights on the river, but the cost of such reservoirs would be well over a billion dollars."[2] (p. 24).

According to the report of Brig. Gen. T. H. Jackson, Division Engineer, Lower Mississippi Valley Division, we find about 270 dam sites were investigated in White River, Arkansas river and Red River basins. Of 13 possible sites on the White River basin, the most desirable combination consisting of eight reservoirs would cost 123,835,000 dollars. This system would reduce flood heights on the Mississippi for a 1927 flood 2·35 feet at the mouth of the White River. The storage provided 10,464,000 acre feet (1 acre-ft. =43,560 cu. ft.) would reduce the contribution of the White in a 1927 flood 164,000 cusecs.

On the Arkansas basin 28 dam sites out of 130 were found to be practicable. "The system embracing the 28 reservoirs would provide a capacity of 12,730,000 acre-feet and would store only about 40 per cent of the 1927 Arkansas flood flow. Their aggregate cost would be about 137 million dollars. More complete and positive control of the Arkansas would be secured by a single reservoir located just above Little Rock. Such a reservoir would have retained the entire 1927 flood with 20 per cent capacity in reserve. Its capacity would be about 29 million acre feet, exactly equal to the maximum estimated capacity of the Boulder Canyon project, its cost 267 million dollars."[2] (p. 48).

On the Red River basin 13 sites were found to be suitable. "In the system of 13 most promising reservoirs selected a capacity of 31,310,000 acre-feet would be provided at a total cost of 157,018,000 dollars. . . . Such a system would retain about 80 per cent of the total maximum flow from these stremes into the Red River backwater. This would reduce a 1927 flood by about 190,000 cusecs at the

* The average unit cost of levee construction is about 25 cents per cubic yard. About 201 million cubic yards were constructed between July 1, 1928 to Dec. 31, 1931, amounting to an expenditure of about 50 million dollars. (Ref. 3, p. 188).

peak of the Mississippi flood at Red River Landing and the superflood at its peak at the same point from 300,000 cusecs to about 60,000 cusecs."[2] (p. 48-49).

Reservoirs are becoming more and more popular in river engineering practice in America. "Reservoirs provide a method of flood control which has received wide and serious consideration. From a strictly engineering standpoint, the reservoir is perhaps the soundest method for flood control. Reservoirs may be constructed and maintained with greater certainty and safety than any other flood work."[3] (p. 289).

It may, however, be noted that the large number of dams suggested in the various flood control projects could not be undertaken for execution all at a time owing to their high installation costs. U. S. A. notable for world's largest dams,* builds her huge artificial lakes for flood control, irrigation, navigation, water supply and electrification, in course of many years, under long-term plans.

4. *Afforestation.*—Although afforestation of bare lands are not directly concerned with flood control, the case should be strongly recommended for preventing erosion of valuable cultivation land. The problem of soil conservation has been a very important item both in agricultural and river training sciences. The problem is more serious in the hilly undulated tracts of U. S. A. and China, and those of the peninsular countries of India. In this connection the report of the Mississippi Flood Control remarks as follows:

"There has been much discussion as to the effect of cultivation and forestry on floods. The improvement of the methods of cultivation to avoid erosion and to conserve ground water, and the forestation of bare areas, both appear to retard or diminish run-off and are to be most strongly encouraged for their intrinsic value. Their effect on floods is too indeterminate in positive result to be relied upon for a cure of the great evil of mighty flood. Yet no help should be cast away or discouraged."[2] (p. 5)

Not only that afforestation protects the valuable soil of the country but it also prolongs the life of the dams by holding off eroded soil, sand and detritus which might otherwise fill the reservoirs at more rapid rate.

In India the soil conservation problems are more serious for the peninsular countries (including Damodar basin) where the soil is more liable to erosion due to the nature of the soil not properly covered with vegitation and under the forces of hill streams. On the otherhand the great plains of India which take the mighty parennial rivers has the grave problem of meandering and caving of banks, and silting in the sluggish flow at the flatter plains, similar to those of the Lower Mississippi Valley.

5. *Dredging.*—Systematic dredging, particularly in the Lower Mississippi has been found to be very effective in maintaining navigation route in the lower reaches, and the method has been strongly recommended by the authorities.

6. *Revetment.*—Strengthening and stiffening of river banks below water level (revetment) has been recommended strongly but applied only sparingly towards the mouth of the Mississippi, as the cost of revetment is almost prohibitive.

The Tennessee Valley Authority

In 1933, yet another organisation was established to tackle the problem of the Tennessee river 800 miles long, which is the largest tributary of the Ohio which, in its turn, flows into the Mississippi.

The Tennessee River influences the agricultural, economic and industrial life of the basin 40,600 sq. miles in extent and inhabited by two million people on the lower valley (agricultural) and some four million towards the upper reaches (industrial). The principal agricultural products of the valley are wheat, maize, cotton and tobacco: Dairying and sheep farming are also carried on. Mineral resources are abundant at the upper reaches where iron and copper ores are mined. Industries include iron and steel, flour, cotton-seed oil, timber, etc.

The Tennessee river creates frequent flood havoc in the basin and is similar, from certain points of view, to the hill streams of the tropics. The river rises from the Appalachian mountains and runs quite steep at the start. It has an average slope of about 1 ft. per mile between Knoxville to Chattanooga, and about 7 inch per mile from Chattanooga to Wheeler Dam. The lower valley of the Tennessee is only a few hundred feet above sea level. The upper catchment areas on the Appalachian highlands receive torrential rain from the storms coming from the Gulf of Mexico during the months of December to April inclusive. Again, thunder-storms, coming from the west, occur during the West Indian hurricane season from July through November. During these summer months the storms come without warning, release torrential downpours into the drainage areas of the Tenessee and a number of its tributaries.

"The Act of Congress in 1933 creating the Tennessee Valley Authority (T. V. A.) has granted broad powers for the fulfilment of a project, the first of its kind in American history, calling for the complete development of an entire watershed. . . . A mean annual rainfall of 51·2 inches, amounting to about 145 billion tons of water, takes its toll of the river valley annually to the extent of about 2,000,000 dollars in flood damages. Furthermore, the river has

carried downstream untold millions of tons of eroded soil during these seasonal fluctuations, building up sandbars and reducing the river's effectiveness as a navigable water-way.

extending over approximately 37 miles of river bed, is 134 feet, only 33 feet less than Niagara Falls."[5]

All the above projects are the undertakings of the Central Government and the Provincial Govern-

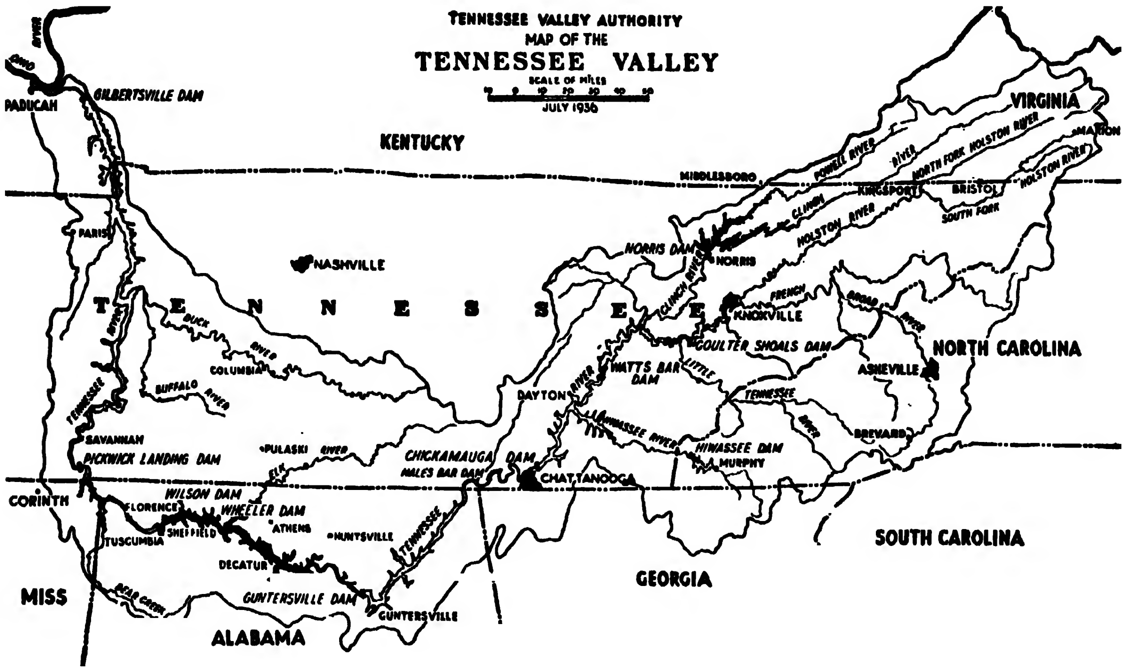

Fig. 2. Contour of the Reservoirs are shown: those completed (1936) are patched black; those under project are only contoured.—(Reproduced from 'Wonders of World Engineering', Vol. 3).

"The authority's answer to these problems is a two-way control program. On the one hand it checks erosion at the head-waters through forestation measures, and on the other, it controls the river itself through an integrated system of storage and run-of-river dams. Storage dams on the large tributaries, such as Norris Dam on the Clinch, will hold back the run-off during the rainy season, thus levelling the flow of the river for navigation and flood control. Run-of-river dams, such as Wilson Dam and Wheeler Dam, in the Muscle Shoals area, graduate the flow of the main stream through a series of long narrow lakes which further reduce flood dangers and are useful for water-borne traffic. From Knoxville, Tennessee, to Paducah, Kentucky, the Tennessee drops 505 feet; narrow stretches of deep water connected by navigation locks will carry river traffic down a gigantic stairway 650 miles in length. Wheeler lake, one of the steps in this stairway, will be 88 miles long.

"The Muscle Shoals area in the Tennessee River is one of the nation's great hydro-electric power sites. . . . The greatest fall in this series of rapids,

ments which are directly concerned, and are planned on a permanent national basis. No piecemeal work can do for the vital problems of the rivers of a country, and the cost of the remedial projects should be gauged not by its figures alone but against the recurring loss of life, property, and revenue of the river basin.

Not only that 'saving' indirectly means 'earning', but also that direct returns of the outlay are obtained in various forms under the river training projects. Highways, water-works, etc. can be improved at the embarked river sides and hydro-electric power stations can be built by the side of the storage dams. For example, the Wheeler power house was planned for an ultimate installation of eight main generating units, having a total capacity of 288,000 kilowatts. Norris Dam on the Clinch River is 83 sq. miles in area to hold 3,600,000 acre-feet or 1,56,800 million cu. ft. of water which may be released when the 'mother river' drops. This will make the river perennial as well as generate about 132,000 kw. of electrical power. The estimate of the T.V.A. in 1935 showed that Wilson Dam could be utilised to generate

a maximum electrical power output of 200,000 kw. The Tennessee Valley Authority is building seven high navigation dams, with resulting benefit of flood control and water power in addition.

It should, however, be borne in mind that one and the same reservoir cannot be effectively used for flood control as well as for power production. For, a flood controlling reservoir should be kept empty to receive the influx of flood water, whereas, a power dam is required to be kept full for driving the turbines. Nevertheless, flood control dams may be well utilised, at times, for power production, when the store of water is released to emptiness. On the other hand an auxiliary power dam may also be located adjacent to a flood control dam. Norris Dam, for example, is primarily a storage dam for feeding the river with perennial flow when the mother river drops. During this period of the year, when the stored up water is released, it generates an electricity of 132,000 horse-power.[8]

Economics of Flood Control Planning

Apart from the necessity of sound technical knowledge of the hydraulics of the river which is to be controlled, the question of layout cost and maintenance cost are of serious consideration, and in most cases the economic question become the guiding factor in planning a flood control project.

As has been already said, the cost should not be gauged by its figures alone. The principle of economy requires that the costs of erection and maintenance of a remedial measure should be reasonable as compared with the value of benefits derived therefrom.

To evaluate such benefits a systematic investigation is required to find (*i*) total damage caused by different types of flood and their frequencies of occurrence and (*ii*) possibilities of further exploitation of the 'trained' river to add to the wealth of the basin.

As to the first point, the damage should include loss of agricultural products, damage to cultivation land, damage to houses and buildings, loss of livestocks, loss of human lives, damage to other properties, damage to highways, railways, bridges, etc., damage to industrial areas, loss by dislocation of traffic and transport, etc. The next point, the direct benefit obtainable by a flood control project may include improvement and establishment of water works, building of highways, establishment of hydroelectric power stations, water mills, improvement of irrigation and consequent raising of more crops, widening of waterways and river borne trade, etc.

The evaluation of the total benefit expressed in terms of money-value and its interest thereof will immediately tell us whether a flood control plan is justified or not. Nobody would justify spending millions and billions of dollars over the Mississippi training projects, of the T.V.A. activities, or in the making of the Boulder Dam, unless he gauges the total national benefits derived out of these projects.

Comparison of the Tennessee and the Damodar Basins

The natural conditions of the Tennessee River in America and the Damodar River in India are very similar. Both of them flow through extremely fertile land in the lower basin, inhabited by dense population, have rich minerals towards the upper reaches, and are visited by sudden and catastrophic floods.

The lessons taught by the Tennessee floods have evolved gigantic engineering methods to tame the fury of the river and to feed the river with perennial flow at other times of the year. The vast amount of water carried down by the river during flood months has been welcomed, during the later developments of engineering feats, to serve the people living on the basin by widening the water route, developing cheap electric power for industries, and supplying water for irrigation and drinking purposes.

The natural bed of the Tennessee river is far from being navigable as it takes a number of 'rapids' or steep slopes at many points. The Wheeler and Wilson Dams smooth out the steepest part of the river bed which drops more than one hundred feet in course of some fifty miles. Locks have been provided to manipulate the water level for navigation across such rapids. A river traffic of about 3,000,000 tons are at present carried along the river, and the T. V. A. expects to increase it to 17,000,000 tons per year by 1950.

The upper catchment of the Damodar River at the Chotanagpur hills receives torrential downpour from sudden monsoon squalls and rain storms rising from the the Bay of Bengal, - a case similar to that of the Tennessee receiving violent downpours on the Appalachian highlands due to the monsoons from the Gulf of Mexico. The methods of flood control in the Damodar has been resorted only to the embankment systems which are built on *ad hoc* engineering methods (details have been discussed in a previous article published in SCIENCE AND CULTURE.[9]) No question of navigation has ever been thought of, on the ground, probably, that the river is too furious to be navigated, and is too low during other months of the year. The slope of the natural river can be controlled by putting water locks to facilitate navigation in the river.

We have seen that the fury of the flooded Tennessee has been tamed down by a chain of large

number of reservoir dams—each several miles in length, and the lower valley have been protected by levees. In the Damodar, however, no attempts have been made to construct dams at its upper reaches and on its powerful affluent the Barakar River. Two pleas were put forth against the construction of dams: first, high cost; and secondly, the possibility of water seepage into the adjacent mines in the Bihar reaches of the river and its tributaries. Subsequently, however, the objection on the geological fault of the bed was removed by the Director of the Geological Survey department, on his closer examination[10] of the site (Parjori) between 1926-29. The upper reaches of the Tennessee lie in the important mining districts of U. S. A., and dams have been constructed on the river with no damage to the adjacent mines. Even if there is any chance of seepage due to faults in the rock-beds at the dam sites, they may be cured by grouting,[8, 11] with cement concrete, as has been done at the Norris Dam by the T. V. A.

The Damodar basin lies in a part of the country which demands badly a perennial stream for irrigation and navigation. It is most unfortunate that the ill-planned levee system of the Damodar has deprived the land of obtaining water from the river for irrigation, and while the tract is capable of raising a number of crops in a year it actually raises only one and that also under the constant threat of flood.

Dams constructed at the upper reaches can save both flood hazards and can prolong the flow up to the autumn crops. The problems of flood control and of making the river perennial go hand in hand and we have already seen how the T. V. A. has solved the problems. The question of navigation can be made possible to facilitate trade and transport in the important rice districts and mineral fields coal in particular, which lie close to the Damodar basin. There is also great scope for developing hydro-electric power.

The integrated problem of flood control, irrigation, navigation, flushing of the country sides to improve malarial conditions, etc. can be tackled by an organisation of scientists and other officials to form a Damodar River Commission or the like, in the manner of the Tennessee Valley Authority or the Mississippi River Commission. Since the Damodar River and its important tributaries flow through Bihar and Bengal, both the Provinces have got to cooperate in the improvement project under the general supervision of the Central Government. Such an organisation is badly needed to improve the Damodar basin. Hydraulic Laboratories should also be brought into existence to deal with the Damodar training problems scientifically.

Conclusion

The present article which reviews the activities of the Mississippi River Commission, the Tennessee Valley Authority and various other bodies, all working harmoniously to promote the condition of the largest river system of the world, shows how they have been organised by the Government of the U. S. A. on a solid national basis embodying far-sighted plans and long-term projects which are based on scientific principles. The training of the rivers and the improvement of the basins have been deeply recognised to be the responsibility of the Government of the country, as the wealth and prosperity of the country depend largely on the proper maintenance of her river system.*

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* My thanks are due to Prof. M. N. Saha, F.R.S., and Dr N. K. Bose, Ph.D., Director, River Research Institute, Bengal, for their kind interest and valuable suggestions in preparing this article.

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DR. WILLIAM BURNS

Dr William Burns, C.I.E., D.Sc., has lately retired from the office of the Agricultural Commissioner with the Imperial Council of Agricultural Research under the Government of India. He has served the cause of agriculture in India in various capacities. After serving for a short period as assistant lecturer to Sir Frederick Keeble (then Professor of Botany in the University of Reading) he entered

Dr W. Burns.

the Indian Agricultural Service in 1908 and was appointed Economic Botanist and Professor of Botany in the College of Agriculture, Poona. Dr Burns threw himself heart and soul into the teaching of students then drawn from every corner of India and even beyond it. Many of these are now holding high positions in agricultural and revenue services of many provinces and States. He also took active part in athletic side of the activities of the institution. He took an active interest in military training and during the last war he commanded the Poona Divisional School of Musketry until 1919 when it was demobilised. In 1922, he became principal of the Poona College of Agriculture and in 1932 became the Director of Agriculture, Bombay. In 1936, Dr Burns was appointed Agricultural Expert with the Government of India (title later changed to that of Agricultural Commissioner). He thus became one of the Head Quarters staff of the Imperial Council of Agricultural Research and in this capacity he has done very useful work not only as regards the action of the council itself but also in relation to the work of the Indian Central Cotton Committee, Indian Central Jute Committee and other bodies. In the discharge of his official duties he had to tour the greater part of India and his wide experience of agricultural condition in India and knowledge of agricultural matters have enabled him to render very useful service to Indian Agriculture. He has been a prolific writer in agricultural, botanical and horticultural matters. These papers will be found in the pages of *Indian Journal of Agricultural Science*, Agriculture and Livestock in India, *Indian Farming* and various other publications. He was twice elected president of the newly formed Indian Society of Plant Breeding and Genetics and delivered the presidential address to the Society in Delhi this year (1944) on the 'Teaching of Plant Genetics'. Dr Purns was awarded the D.Sc. degree of the University of Edinburgh in 1914, and the Government of India bestowed on him the C.I.E. in 1939. He relinquished the post of Agricultural Commissioner on August 22, 1943 and was thereafter on special duty for two months. His scientific contributions were mainly in the realms of plant genetics and the improvement of grass lands. He edited and wrote Section IV of the highly popular book "Sons of the Soil", of which the second edition is now exhausted and the third in the press.

Notes and News

OBITUARY

ALES HRDLICKA

ACCORDING to a report of *Science*, September 17, 1943, death has occurred of Dr Ales Hrdlicka, the distinguished anthropologist and curator of the Division of Physical Anthropology of the U. S. National Museum. A native of Pohemia, Dr Hrdlicka studied, worked and passed his eventful life in America. He received his early training in medicine and obtained a degree at the Electric Medical College of the City of New York in 1892 and another from the New York Homoeopathic Medical College in 1894. He joined the staff of the State Homoeopathic Hospital for the Insane at Middletown and also became affiliated with the Pathological Institute of the N. Y. State Hospitals.

He gradually became more interested in anthropology in which science he has left his indelible mark. In 1903, he became assistant curator and in 1910 curator of the Division of Physical Anthropology of the U. S. National Museum. In this capacity he published several original articles and books. He founded the *American Journal of Physical Anthropology*, of which he was editor from 1918 to 1942, and established the American Association of Physical Anthropologists in 1929, of which he was president from 1929 to 1932.

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Dr Hrdlicka made extensive trips all over the world for field work in his anthropological investigations. He was the recipient of many honours and honorary degrees. He became Chairman of the Anthropological Society of Washington (1907), of the American Anthropological Association (1925-1926), and of the Washington Academy of Sciences (1920). He was a member of the National Academy of Sciences (1929) and of the American Philosophical Society.

SCIENTIFIC RESEARCH IN GREAT BRITAIN

IN the British House of Lords on July 20, there was a continuation of the debate on a motion by Viscount Samuel calling attention to the need for the further expansion of scientific research. Lord Dawson pointed out that "It was difficult to overstress the importance where science was concerned—and this applied equally to medicine—of preventing the enmeshment of any research body in the close entanglement of a Government department. One of the chief reasons why these research bodies should receive further support was that they succeeded in combining good order in the work of men of ability with freedom for scientific investigation".

Lord Cherwell said in part "that the importance, from the economic point of view, of fostering pure fundamental research could not be overlooked."

The Government recognized that pure research must be, in a large measure, its responsibility and must be done at the universities; but naturally, they also wished to encourage industry to spend money on pure research. It was the Government's policy and intention to increase its aid for research, and it would welcome any developments of industry in a similar direction. The treatment of scientists in the Civil Service had been mentioned, and he frankly admitted that the Civil Service had not hitherto shown due regard for the contribution scientists were making to the nation's welfare. This matter had now been reviewed, and an investigation had been in progress to make sure that the conditions of service, pay and prospects of Government scientific employees compared favourably with those on the administrative side. He hoped that a definite announcement on these reforms might be made before long. There were probably not more than a few dozen physicists in Great Britain capable of evolving and developing new applications of, say, the various radio devices on which success in this war very largely depended. Every one would agree that it was an anomaly to pay them on lower scales than men of equal educational status who, because they had distinguished themselves in what were usually called "humane" subjects, were often given war jobs of much higher status and pay than the scientist. *Science*, Vol. 98, No. 2541.

The contact of research workers and research organisations with the highest administrative circles of the Government *viz.* the Cabinet has gone still higher. In course of the war, a pure scientist, Prof. F. A. Lindeman, sometime Professor of Experimental Physics in the University of Oxford, now Lord Cherwell, has been taken in the Cabinet as Pay Master General and we believe one of his functions is not to allow his colleagues of the Government to grow lukewarm about the importance of research, to get money for research and to see that basic principles which lead to efficiency are not sacrificed.

ARDESHIR CURSHETJEE—THE FIRST INDIAN FELLOW OF THE ROYAL SOCIETY OF LONDON

It was so long believed that the late Mr S. Ramanuyam of Madras was the first Indian to be elected to the Fellow of the Royal Society of London. Prof. A. V. Hill, Secretary of the Royal Society, however, discovered from the archives of the society that the first Indian to be elected to this honour was one Mr A. Curshetjee in 1841. Nothing was known about him, however, and at the request of Prof. Hill, Sir R. P. Masani, lately Vice-Chancellor of the Bombay University unearthed the following life history of Mr Curshetjee.

Ardeshir Curshetjee was born in 1807 in the city of Bombay. In 1822 he served under his father in Government Dock-yard and became Assistant Builder. In 1833 he built a small steamer "Indus" in the Mazagon Dock and personally fixed up all machinery. He is reported to have made experiments in connection was gas lighting and to have fixed up all pipes and gas machinery in his bungalow at Mazagon, Bombay, and it is recorded in Parsi annals that the Earl of Clare, Governor of Bombay, inspected the installation on 10th March, 1834 and gave him a "Dress of Honour". In 1836 he was appointed non-resident member of the Royal Asiatic Society of Great Britain and Ireland. In 1839 Ardesir Cursetjee went to England for further studies in mechanical engineering. There his services were engaged by the Court of Directors of the East India Company in the workshop of Messrs. Wards and Keppel. The chronicles further state that he was introduced to Queen Victoria on the 1st July, 1840 and that he thereafter published a book of his notes regarding his travels in England. He returned to Bombay in 1841 and was appointed Chief Engineer of the Steam Factory and Foundry on a salary of Rs. 600/-. In 1839, he was elected Vice-President of the Mechanics Institute. He went to England for the second time in 1851, was made a Justice of the Peace in 1855 and retired on pension on 1st August 1857. In 1859 he went to England for the third time and in 1861 was appointed Chief Resident Engineer of the Indus Flotilla Company at Karachi, and there he built three or four steamers navigable in the Indus. In 1864, he went to England for the fourth time and passed there the rest of his life until his death on 16th November, 1877, at the age of seventy.

DAMODAR FLOOD ENQUIRY COMMITTEE

The Damodar Flood Enquiry Committee constituted by the Government of Bengal to advise on permanent measures to control floods in the Damodar river recently held its first meeting, with the Minister for Communication and Works in the Chair. The Committee has been constituted with the Maharajadhiraj of Burdwan as its Chairman and Dr M. N. Saha, Professor of Physics, Calcutta University, Mr C. C. Inglis, Director, Central Irrigation and Hydrodynamic Research Station, Poona and Rai Bahadur Kanwar Sain of the Punjab as some of its distinguished members. An aerial map of the Damodar river covering a length of 80 miles was exhibited at the meeting.

The Hon'ble Minister, in course of his address, drew attention to this once prosperous track of Bengal, which has now become a moribund land with malaria taking a heavy toll every year. He wanted the Committee to advise particularly on the report which was submitted nearly 21 years ago by Mr Addams-Williams and Mr Glass on behalf of the Government. The above expert enquiry ordered by the Government of Bengal under pressure of public opinion lasted for over seven years, and the recommendations were published in a pamphlet issued by the Government. The recommendations, according to the Hon'ble Minister, deserve serious consideration in the working out of any future plan of action to prevent the incidence of such floods in the Damodar river. He referred to the Tennesse Valley, U. S. A., which offers the nearest parallel to the Damodar. The Tennesse Valley Authority created by the Government, in 1933, have spent within the last ten years about 37 million pounds and have erected 11 storage and navigation dams throughout the entire length of the river, which have converted the river into a great perennial navigation channel. Two huge hydro-electric plants have been erected which are producing twice as much electricity as the city of Calcutta requires, and an area of half the size of Bengal is now prosperous and happy.

In his concluding remarks, he wanted the Committee to suggest long-term remedial measures which will include not merely the protection of the Railway and the Road, but also the entire problem of protection, irrigation and health and not one of them at the expense of the other.

He further informed the Committee that the Central Government, after the Damodar Flood Enquiry Committee was announced, had also appointed a Technical Committee of three to consider this important problem. He also revealed that Mr Savage, the famous American dam expert is at present in this country and that the Government is arranging to make his advice available to the Committee.

We further understand that the Committee has recently visited the dam sites in the Hazaribagh district.

number of reservoir dams—each several miles in length, and the lower valley have been protected by levees. In the Damodar, however, no attempts have been made to construct dams at its upper reaches and on its powerful affluent the Barakar River. Two pleas were put forth against the construction of dams: first, high cost; and secondly, the possibility of water seepage into the adjacent mines in the Bihar reaches of the river and its tributaries. Subsequently, however, the objection on the geological fault of the bed was removed by the Director of the Geological Survey department, on his closer examination[10] of the site (Parjori) between 1926-29. The upper reaches of the Tennessee lie in the important mining districts of U. S. A., and dams have been constructed on the river with no damage to the adjacent mines. Even if there is any chance of seepage due to faults in the rock-beds at the dam sites, they may be cured by grouting,[8, 11] with cement concrete, as has been done at the Norris Dam by the T. V. A.

The Damodar basin lies in a part of the country which demands badly a perennial stream for irrigation and navigation. It is most unfortunate that the ill-planned levee system of the Damodar has deprived the land of obtaining water from the river for irrigation, and while the tract is capable of raising a number of crops in a year it actually raises only one and that also under the constant threat of flood.

Dams constructed at the upper reaches can save both flood hazards and can prolong the flow up to the autumn crops. The problems of flood control and of making the river perennial go hand in hand and we have already seen how the T. V. A. has solved the problems. The question of navigation can be made possible to facilitate trade and transport in the important rice districts and mineral fields—coal in particular, which lie close to the Damodar basin. There is also great scope for developing hydro-electric power.

The integrated problem of flood control, irrigation, navigation, flushing of the country sides to improve malarial conditions, etc. can be tackled by an organisation of scientists and other officials to form a Damodar River Commission or the like, in the manner of the Tennessee Valley Authority or the Mississippi River Commission. Since the Damodar River and its important tributaries flow through Bihar and Bengal, both the Provinces have got to cooperate in the improvement project under the general supervision of the Central Government. Such an organisation is badly needed to improve the Damodar basin. Hydraulic Laboratories should also be brought into existence to deal with the Damodar training problems scientifically.

Conclusion

The present article which reviews the activities of the Mississippi River Commission, the Tennessee Valley Authority and various other bodies, all working harmoniously to promote the condition of the largest river system of the world, shows how they have been organised by the Government of the U. S. A. on a solid national basis embodying far-sighted plans and long-term projects which are based on scientific principles. The training of the rivers and the improvement of the basins have been deeply recognised to be the responsibility of the Government of the country, as the wealth and prosperity of the country depend largely on the proper maintenance of her river system.*

* My thanks are due to Prof. M. N. Saha, F.R.S., and Dr N. K. Bose, Ph.D., Director, River Research Institute, Bengal, for their kind interest and valuable suggestions in preparing this article.

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DR. WILLIAM BURNS

Dr William Burns, C.I.E., D.Sc., has lately retired from the office of the Agricultural Commissioner with the Imperial Council of Agricultural Research under the Government of India. He has served the cause of agriculture in India in various capacities. After serving for a short period as assistant lecturer to Sir Frederick Keeble (then Professor of Botany in the University of Reading) he entered the Indian Agricultural Service in 1908 and was appointed Economic Botanist and Professor of Botany in the College of Agriculture, Poona. Dr Burns threw himself heart and soul into the teaching of students then drawn from every corner of India and even beyond it. Many of these are now holding high positions in agricultural and revenue services of many provinces and States. He also took active part in athletic side of the activities of the institution. He took an active interest in military training and during the last war he commanded the Poona Divisional School of Musketry until 1919 when it was demobilised. In 1922, he became principal of the Poona College of Agriculture and in 1932 became the Director of Agriculture, Bombay. In 1936, Dr Burns was appointed Agricultural Expert with the Government of India (title later changed to that of Agricultural Commissioner). He thus became one of the Head Quarters staff of the Imperial Council of Agricultural Research and in this capacity he has done very useful work not only as regards the action of the council itself but also in relation to the work of the Indian Central Cotton Committee, Indian Central Jute Committee and other bodies. In the discharge of his official duties he had to tour the greater part of India and his wide experience of agricultural condition in India and knowledge of agricultural matters have enabled him to render very useful service to Indian Agriculture. He has been a prolific writer in agricultural, botanical and horticultural matters. These papers will be found in the pages of *Indian Journal of Agricultural Science*, Agriculture and Livestock in India, *Indian Farming* and various other publications. He was twice elected president of the newly formed Indian Society of Plant Breeding and Genetics and delivered the presidential address to the Society in Delhi this year (1944) on the "Teaching of Plant Genetics'. Dr Burns was awarded the D.Sc. degree of the University of Edinburgh in 1914, and the Government of India bestowed on him the C.I.E. in 1939. He relinquished the post of Agricultural Commissioner on August 22, 1943 and was thereafter on special duty for two months. His scientific contributions were mainly in the realms of plant genetics and the improvement of grass lands. He edited and wrote Section IV of the highly popular book "Sons of the Soil", of which the second edition is now exhausted and the third in the press.

Dr W. Burns.

Notes and News

OBITUARY

ALES HRDLICKA

According to a report of *Science*, September 17, 1943, death has occurred of Dr Ales Hrdlicka, the distinguished anthropologist and curator of the Division of Physical Anthropology of the U. S. National Museum. A native of Bohemia, Dr Hrdlicka studied, worked and passed his eventful life in America. He received his early training in medicine and obtained a degree at the Electric Medical College of the City of New York in 1892 and another from the New York Homoeopathic Medical College in 1894. He joined the staff of the State Homoeopathic Hospital for the Insane at Middletown and also became affiliated with the Pathological Institute of the N. Y. State Hospitals.

He gradually became more interested in anthropology in which science he has left his indelible mark. In 1903, he became assistant curator and in 1910 curator of the Division of Physical Anthropology of the U. S. National Museum. In this capacity he published several original articles and books. He founded the *American Journal of Physical Anthropology*, of which he was editor from 1918 to 1942, and established the American Association of Physical Anthropologists in 1920, of which he was president from 1929 to 1932.

Dr Hrdlicka made extensive trips all over the world for field work in his anthropological investigations. He was the recipient of many honours and honorary degrees. He became Chairman of the Anthropological Society of Washington (1907), of the American Anthropological Association (1925-1926). and of the Washington Academy of Sciences (1929). He was a member of the National Academy of Sciences (1929) and of the American Philosophical Society.

SCIENTIFIC RESEARCH IN GREAT BRITAIN

In the British House of Lords on July 20, there was a continuation of the debate on a motion by Viscount Samuel calling attention to the need for the further expansion of scientific research. Lord Dawson pointed out that "It was difficult to overstress the importance where science was concerned—and this applied equally to medicine—of preventing the enmeshment of any research body in the close entanglement of a Government department. One of the chief reasons why these research bodies should receive further support was that they succeeded in combining good order in the work of men of ability with freedom for scientific investigation".

Lord Cherwell said in part "that the importance, from the economic point of view, of fostering pure fundamental research could not be overlooked."

The Government recognized that pure research must be, in a large measure, its responsibility and must be done at the universities ; but naturally, they also wished to encourage industry to spend money on pure research. It was the Government's policy and intention to increase its aid for research, and it would welcome any developments of industry in a similar direction. The treatment of scientists in the Civil Service had been mentioned, and he frankly admitted that the Civil Service had not hitherto shown due regard for the contribution scientists were making to the nation's welfare. This matter had now been reviewed, and an investigation had been in progress to make sure that the conditions of service, pay and prospects of Government scientific employees compared favourably with those on the administrative side. He hoped that a definite announcement on these reforms might be made before long. There were probably not more than a few dozen physicists in Great Britain capable of evolving and developing new applications of, say, the various radio devices on which success in this war very largely depended. Every one would agree that it was an anomaly to pay them on lower scales than men of equal educational status who, because they had distinguished themselves in what were usually called "humane" subjects, were often given war jobs of much higher status and pay than the scientist. *Science*, Vol. 98, No. 2541.

The contact of research workers and research organisations with the highest administrative circles of the Government *vs.* the Cabinet has gone still higher. In course of the war, a pure scientist, Prof. F. A. Lindeman, sometime Professor of Experimental Physics in the University of Oxford, now Lord Cherwell, has been taken in the Cabinet as Pay Master General and we believe one of his functions is not to allow his colleagues of the Government to grow lukewarm about the importance of research, to get money for research and to see that basic principles which lead to efficiency are not sacrificed.

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RECONSTRUCTION OF EDUCATION

THE new scheme for educational reconstruction outlined by Mr John Sargent, Educational Adviser to the Government of India, in his Presidential Address on "Practical Aspect of Educational Reconstruction" for the section of Psychology and Educational Science of the Indian Science Congress, has attracted widespread attention in this country. Mr Sargent has summarised the essential educational requirements of India in twelve points as follows: —

(1) Universal, compulsory and free education for all boys and girls from the age of 5 or 6 until 14, in order to ensure literacy and the minimum preparation for citizenship.

(2) A reasonable provision of education before the compulsory age for school attendance in the form of nursery schools and classes. This is important mainly in the interest of health, particularly in areas where housing conditions are unsatisfactory.

(3) Secondary or high school education for those children who show the capacity for benefiting by it. Probably to satisfy this requirement provision should be made ultimately in high schools of various types for not less than 20 per cent of the boys and girls in each age-group. Variety both in types of school and in the curricula of individual schools is essential to suit the varying tastes and aptitudes of the individual pupils on the one hand and the requirements of their future occupations on the other. In addition, so that no boy or girl of outstanding ability may be debarred by poverty from further education, liberal financial assistance in the form of free places, scholarships and stipends must be forthcoming.

(4) University education, including post-graduate and research facilities for picked students. It is difficult to fix a quantitative standard here but probably when a High School system as contemplated above has been fully established, about one pupil in every 15 should be found fit to proceed to a University.

(5) Technical, commercial and art education. The amount, type and location of this will necessarily be determined to a large extent by the requirements of industry and commerce.

(6) Adult education, both vocational and non-vocational of all kinds and standards, to meet the needs of those who were denied adequate opportunities in their earlier years or who recognise the importance of supplementing what they then received.

(7) Arrangements for training the vast army of teachers which a system of this kind will require.

(8) An efficient school medical service, which will see that children are made healthy and kept healthy. This means treatment as well as inspection and the provision of proper nourishment in necessitous cases. It is a waste of time and money to try to teach a child who is underfed or conscious in other ways of serious physical discomfort. Health also postulates the provision of hygienic buildings in suitable surroundings, the right kind of furniture and equipment and ample facilities for physical training and games.

(9) Special schools for children suffering from mental or physical handicaps.

(10) Recreational facilities of all kinds, to satisfy the craving for corporate activity and to counteract the drabness of the conditions in which so large a part of the Indian people otherwise spend their lives.

(11) Employment Bureaux, to guide school and college leavers into profitable employment and so far as possible to adjust the output of the schools to the capacity of the labour market.

(12) An administrative system which will place initiative and authority in the hands of those who understand and care about education.

We perfectly agree with Mr Sargent that these requirements can hardly be described as extravagant. These have been accepted as the minimum educational needs of every civilised country and, as he pointed out, have been covered by the British educational system as it existed even before the war. In many parts of the United States of America and in some European countries far more liberal provisions have been made in the field of education. He has rightly realised that the Indian problem of educational reconstruction is as colossal as it was in the case of Russia before the Revolution and should be dealt with as efficiently and quickly as it appears to have been done in that country.

Mr Sargent proposes to introduce his scheme in the form of eight five-year programmes requiring, therefore, nearly half a century before any visible result of the scheme will be forthcoming. He has estimated the cost of the scheme at about two crores and eighty lakhs of rupees annually. Thus the Government of India, if they finally so choose to give effect to his scheme, must be prepared to bear this huge expense for such a long period.

It is over this imperative question of financing the scheme that grave doubts have been expressed as to the practicability of his plan. Mr Sargent also seems to be aware of this difficulty and has suggested that it will not be difficult to solve the financial problem if the Government of India decide to divert a part of the huge expenditure now incurred on war to education in the post-war period. However sound the suggestion may be, the present foreign Government representing vested interests in India will probably find the scheme hardly acceptable on the traditional ground of paucity of funds. Similar, but far less ambitious, schemes were put forward on several occasions in the past by distinguished and capable educationists of this country. For instance, mention may be made of late Mr Gokhale's scheme of free compulsory education. But none of them has so far been found acceptable on financial grounds. Any scheme for educational reconstruction, however moderate, for a vast country like India with appalling mass-illiteracy needs must be expensive. Reconstruction in education is an important part of nation-building activity for whose promotion the Government exist. Curiously enough the Government have seldom suffered from paucity of funds in financing schemes in which they are interested, and almost invariably such schemes were remotely connected with

any nation-building activity. Only money is not available in financing projects calculated to promote national interests. From these considerations, the fate of Mr Sargent's scheme is almost a foregone conclusion, and as a daily paper puts it in its editorial comment, the scheme would be merely one more decoration for the archives of the Imperial Secretariat.

ANNOUNCEMENTS

APPLICATIONS are invited for Six Scientific Research Scholarships of the value of Rs. 150/- per month each for the year 1944-45.

The Scholarships are open to men and women, and will be tenable for a period of twelve months commencing from the 1st July, 1944. Any or all the scholarships may be extended for a further period of twelve months, within the discretion of the Trustees. All old scholars who desire renewal should re-apply.

Applicants, who must be of Indian nationality, must be Graduates in Medicine or Science of a recognised University.

The subject of scientific investigation which they may select must have a bearing directly or indirectly on the alleviation of human suffering from disease.

Applications must be forwarded through the Director of a recognised Research Institute or Laboratory where the candidate proposes to work and must be accompanied by a letter from the Director stating that he has critically examined the details of the proposed Research, that he approves of the general plan and that he is willing, as far as possible, to guide and direct the investigation and give laboratory facilities.

Full particulars may be had from the Secretary, Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay.

WE are glad to announce that a further sum of Rs. 2,500/- donated by Messrs. Adair, Dutt & Co. Ltd. has now been placed at the disposal of the Adair Dutt Research Fund Committee for the Calcutta centre, the total amount donated by the said firm being Rs. 9,000/-.

WE note with great satisfaction that Prof. A. V. Hill, F.R.S., Secretary of the Royal Society, London, has been elected honorary member of the Indian Science Congress Association.

SCIENCE IN INDUSTRY

UTILISATION OF CITY SEWAGE

UTILISATION of city sewage waste has attained considerable importance in recent years as a reasonable source of several important products, such as dried sludge as a fertiliser, methane gas for operating internal combustion engines, liquid effluent for irrigation and industrial water, grease, nitrogen and a whole host of useful by-product hitherto neglected. An useful account of these by-products from sewage waste has been given in the *Scientific American*, September, 1943. The dried digested sludge resembling humus in appearance and texture is now widely used for soil conditioning and can also be used as a low-grade fertiliser. The sludge contains, as recent chemical analysis indicates, appreciable amounts of nitrogen (2·25 per cent), phosphorus (1·50 per cent) and potassium (0·70 per cent) and minute quantities of 'micro-nutrient' elements, such as boron, copper, zinc, manganese and others. Some cities of the United States are now producing high-grade fertiliser, using sludge as a base.

The sludge gas is now widely used in U. S. A. and the Continent to operate stationary internal combustion engines and also in running vehicles. According to a report of the American Society of Civil Engineers, 1000 c.c. of sludge gas having an average calorific content of 650 B.T.U. per c.c. are equivalent to 6·4 gallons of butane, or 5·2 gallons of gasoline, or 4·6 gallons of Diesel oil. In 1935, there were about 100 trucks in the Ruhr district, which were equipped to use this gas as fuel. Besides, the conversion of an oil-operated engine into one using sludge gas involves comparatively simple changes.

The war has increased the importance of sewage waste as a source of grease. It has been estimated that about 180 to 365 tons of crude fats are present in the sludge of a city having a population of 100,000 people. Several American cities, such as New York, Chicago and others are now recovering grease from their sewage disposal plants. One plant at Bradford is now alone supplying, it is reported, some 500 tons

of grease weekly. According to a process recently developed, grease is extracted by adding sulphuric acid to the sewage to crack soaps and precipitate the wool waxes. The resulting sludge is then heated and filter-pressed through cotton cloth. Liquid grease and water are obtained in this way, from which the product is finally freed from impurities.

The liquid effluent from the sewage treatment plants is now used in several places of America for irrigation purposes. The sterile soil, covering an area of over 40 acres at Vineland, New Jersey, has now been remarkably improved by distributing through an under ground tile system the sewage of this town. Further the diluted sewage effluent promotes the growth of plant algae and protozoa and has been used in Germany to improve fish culture with good results.

The consideration of such important by-products has made the question of sewage disposal extremely important. Following is the brief account of the modern sewage disposal method largely practicised in U. S. A. Water carried wastes collected by the intricate net work of sewars under city streets are either discharged into neighbouring streams or brought together in a single conduit leading to a treatment plant. The plant separates the solids from the liquid and then digests the putrescible solids. Another method is to treat the liquid containing solids in solution or in suspension by aeration or filtration by which most of the offensive organic matter is oxidised and rendered innocuous. It has been estimated that one ton of sewage flow contains only about one pound of putrescible solids to be removed by treatment. A little more than 25 per cent of these solids settles out in the huge, concrete sedimentation tank provided for this purpose, the balance remaining with the liquid to be oxidised or discharged into a stream where natural processes of purification are active. From the sedimentation tank the highly putrescible material, known as raw sludge, is transferred to closed, heated tanks where anerobic digestion takes place at a temperature of about 80°F. During this process, requiring about 3c days, the raw sludge is decomposed to produce the sludge gas containing about 70 per cent methane. The residue is stable, can be easily dried and subsequently used for soil-conditioning, as referred to above.

INSPECTION TOOLS OF GLASS

THE need for conserving valuable tool steel has necessitated designers to seek newer materials for the manufacture of gages. Outstanding of all these is glass which not only has resulted in the saving of valuable metals, but also in producing gages which outclass steel ones in many respects.

The actual production of glass gages started about one and half years ago, mainly through the efforts of the leading American Glass manufacturers and the United States Army Ordnance Department. At first their design was similar to steel gages. However, as experience accumulated, modifications had to be incorporated to suit the altered characteristics of the material, especially to the risk of chipping, facility of handling and limit breakage. Thus the original chamfered plug gages of glass have now been replaced by a levelled pilot with rounded corners, while the levelling and rounding for snap and ring gages are carried on to a considerably greater extent than in steel. Glass gage sections are generally thicker than like steel ones while the frame of the former is kept inside a wooden or plastic casing to prevent breakage. It is interesting to note that, contrary to the general impression, glass gages are neither fragile nor easily broken, while their abrasive resistance is very high, tests on a ring gage indicating that 2,00,000 passes of a steel plug result in an average wear of only 0·000065 inch.

Glass gages can be produced either by drawing, moulding or rolling as in the case of ordinary commercial glass. At present they are made from ordinary light flint and borosilicate glass, in the form of plug, ring and snap gages (varying from ¼ inch to 5 inches in diameter); profile, position and chamber gages; and certain types of flush pin gages. With the distinct advantages they possess over their metallic prototypes in the form of greater visibility in inspection, freedom from corrosion and rust, elimination of greasing during storage and shipment, reduction in the secondary effects (and consequent increase in efficiency) due to the lower thermal conductivity of glass as compared with steel, maintenance of high functional properties even with slight scratches and chipping, and a more pronounced sense of feel, a definite place has been established for these glass tools which can be regarded as the most valuable precision instruments for dimensional control in the realm of production engineering.

S. K. G.

GEOPHYSICS AND FOUNDATION ENGINEERING

DR GARLAND, of the Geographical Seminar of Strasbourg University, defines geophysics as that branch of science which lies between pure physics on one hand and physical geography and geology on the other and which in its widest sense deals with the study of the history and constitution of the earth. Among the many branches it embodies, applied geophysics is one with which foundation engineering is directly interconnected.

Applied geophysics aims particularly in discovering the nature of the strata lying below the earth without incurring the full experience of making a direct test by shaft sinking, tunnelling or boring. Several methods have upto now been employed, the commonest being the Gravimetric, Magnetic and the Seismic. Recent advances in Soil Mechanics have, however, led to the development of the Electrical and the Electro-seismic methods of exploration. The former, which is based on Maxwell's Theory of Electrostatic Images aims in detecting the strata by means of electric currents either generated naturally as a result of the oxidation of the ores by the circulating waters and producing a difference of potential at varying points, or by artificially producing an electric current into the earth by two "current" electrodes and investigating the strata by two or at times three "potential" electrodes. By varying the distance between the latter and evaluating their results from a set of formulae developed from known strata conditions, a relation between the depth of strata and its resistivity can be obtained. Important sites for large structures such as bridge piers and dams can very well be investigated by this method provided great care is taken in the final interpretation of results. Some time back, experiments carried out in America revealed the amazing fact that if a wireless set is tuned on to a station, the strength of the signal dies down on approaching a fault and the set becomes completely silent when kept exactly over the fault-plane. Further investigations in this field will probably open out many useful and interesting applications in the domain of geophysics.

In the latter, *viz.*, the electro-seismic method, not only does the work serve to guide the drilling programme and supplement the borings with less expensive tests for the determination of the depth of the strata and its compaction condition, but also serves to determine the actual bearing capacity of the soil. The general procedure is that near a given place, vertical harmonic vibrations are set up by a one or two horse-power electric motor having eccentric disks rotating in opposite directions. By changing the eccentricity the centrifugal force can be changed resulting in an increase or decrease of vibrations at various distances from the vibrator. By means of small seismographs these varying vibrations can be measured and resonance curves plotted. From these it is found that high natural frequencies and high phase-speeds indicate a high bearing capacity of the soil, the actual values being obtained from tables of phase-speeds and frequencies in relation to the respective bearing capacities of the soil obtained from a set of existing and known conditions. The dynamic bedding value (*i.e.* the pressure in lbs. per square inch required to cause an elastic vertical deflection of one inch) which is determined by the natural frequency of vibration, reveals, that as the static pressure increases the dynamic value approaches a constant maximum, a fact which is never revealed by static tests. A further useful purpose served by the vibrator is in the consolidation of the soil as compared with ordinary ramming, for, by the application of the former greater efficiency and depth of penetration can be attained.

When the work of drilling is to be supplemented by seismic methods, a portable type of apparatus can be used. With the detector placed in a line on the gravel, light dynamite charges at 3 feet depth are fired in succession at increasing distances along the line. By film records the time of arrival of the waves can be noted and results plotted as a time distance chart. By this procedure it was found in one of the dam sites, that only 400 determinations on land were necessary with results that would normally have required 15,600 feet of drilling and would have cost four times as much. A similar method seems to be applicable for the exploration in the beds of swift waters. Further advances in these geophysical methods of prospecting will open out a mine of useful information which can be beneficially utilised in foundation engineering.

S. K. G.

THE GLASS-MAKING SAND-ROCK OF JUBBULPORE, CENTRAL PROVINCE

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THE area in the neighbourhood of Jubbulpore has received attention from several geologists, particularly, J. G. Medlicott[1] and Dr C. A. Matley[2] whose publications comprise standard communications on this area. The glass sands which occur at a short distance to the east of the town of Jubbulpore, so far as the author is aware, have not been examined in detail, and a preliminary investigation was undertaken by the author. A chemical analysis of the Jubbulpore glass sand has been given by Messrs. Mukerji and Drane in their short note on "Indian Glass-Making Sands."

LOCALITY

The city of Jubbulpore is situated about 1,300 feet above the sea-level and towards the east, the Chui hill, the famous repository of fire clay is situated. Towards the north, this hill has a broad east-west elongation and at the northern end these glass sands are exposed at an altitude of about 1,400 feet above the sea-level and the main road leading to Shahpura runs only a little north of it. At this locality the sand-rock is being quarried at present but there are other outcrops of the same rock which occur elsewhere in the neighbourhood. On the north and across the road, the range of granite hills, locally known as Sidh Baba Ka Pahar, occurs.

THE NATURE OF THE DEPOSIT

This deposit of the sand-rock belongs to the Jabalpur Group which comprises in descending order:—

(i) Clays of variegated colour,
(ii) Sandstones.

The sandstones can in places be further subdivided, in descending order, as near the quarry into:—

(i) White clean sand-rock, suitable for glass-making.
(ii) Reddish, yellowish or brownish felspathic sand-stones.

The sand-rock is succeeded by fire-clays of various colours and grades. The latter are of whitish, yellowish, greyish and almost black colour, in places with dark carbonaceous impressions and tiny inclusions of coal. These clays have a great commercial importance.

By the earlier writers, Jabalpur beds were considered to be of Middle Jurassic age but Dr C. A. Matley has suggested tentatively a Lower Cretaceous age.

The sand deposits, which are quarried for the manufacture of glass, occur about 150 yards almost due north of the temples on the Chui hill. The overburden is very small and as observed in December, 1942 it is about one foot in thickness, but in places the maximum thickness does not exceed three to five feet.

The present excavation is almost circular in form. The quarry has a length of about 200 feet in an east-west direction and a width of a little over 100 feet in a north-south direction. The maximum height of the quarry face measured 26 feet.

The rock is a white sand-rock, which is quite incoherent and friable so much so that on every handling some grains of quartz are dislodged. With the aid of a pocket lens it is seen to consist of a somewhat medium-grained particles of quartz loosely cemented together by a somewhat sparse matrix of kaolin. There are occasional specks of biotite, muscovite, hornblende and magnetite. Chalcedony, which is of markedly dull waxy, faint grey colour and sometimes occurs in large grains, is also associated. Some grains of quartz are partially coated with white kaolin. Occasionally, fine lenticles of white clay, scarcely an inch thick and a few inches in length, occur in the sand-rock. In places, where the rock is more fine-grained, the proportion of white clay increases. It has a softer touch and soils the fingers. A solitary small reddish pebble of quartzite was collected from near the top.

Coarser and darker bands are seen interbedded with the sand-rock. They present a very irregular disposition. They vary in thickness from a fraction of an inch to about three inches in thickness. Sometimes these coarse bands are in the form of small lenticles. It is noteworthy that as these lenticles are composed of very coarse grains, they get eliminated largely from the glass sand on sieving.

QUARRYING, WASHING AND SIEVING OF THE GLASS SAND

The rock is soft and therefore holes are bored with chisels by manual labour and then the rock is blasted with gun powder. The broken rock is then transported to the glass works. It is there pulverised into sand with flat wooden

[1] Medlicott, J. G., On the Geological Structure of the Nerbudda Valley, *Mem. G. S. I.*, Vol. II, 1860.
[2] Matley, C. A., On the Stratigraphy, Fossils and Geological Relations of the Lameta Beds of Jubbulpore, *Rec. G. S. I.*, Vol. LIII, 1921.

hammers. The sand is then filled in open glass pots and washed with water by coolies. The clay is removed by trampling the wet sand under the feet. It is then dried on fire by heating the sand on an iron-sheet. This dry sand is finally passed through a siever when pieces of rock and coarser grains are separated. The sieving is so arranged that it passes through 16 mesh and is retained on 100 mesh.

This sand is both used in the Glass Works at Jubbulpore and Condia. It was also exported to Ishapur and Jamshedpur at Rs. 15/- per ton (1942) f.o.r. Jubbulpore.

Microscopic Characters of the Sand-Rock

A thin section is seen to be composed of grains of quartz, which have a subangular outline but some of them have an elongated prismatic shape. A few pieces are observed to be almost angular. Inclusions of biotite, tourmaline and diopside are observed in quartz under high power. A few light brownish patches, which are somewhat pleochroic and show a very weak birefringence, are of chlorite formed by the alteration of biotite. In some places it occurs in very fine patches and shows aggregate polarisation. In places tiny flakes of muscovite, showing bright polarisation colours and straight extinction, are present. Tiny particles with yellowish colour, high refractive index, strong but varying birefringence, are of epidote. A dark coloured patch, appearing whitish by reflected light, appears to be of kaolin. In places, the tint appears reddish white under reflected light indicating staining of iron. A prismatic section of brownish tourmaline with characteristic pleochroism and straight extinction is observed. A few minute specks of magnetite, black and opaque by transmitted light and steel-grey by reflected light, are also present. The matrix is composed of kaolin in which islands of grains of clear and colourless quartz are to be observed. Of course it is to be noted that a very great bulk of the rock is composed of quartz grains, the other minerals occur as impurities, some of which are observed only under high power.

Mineralogical Composition of the Glass Sand

The glass sand, which is actually used in the manufacture of glass, after the rock has been crushed, washed and sieved, was also examined. A very great bulk of the quartz grains are colourless with a partial and fine coating of kaolin. By panning, the coloured particles in the sand were concentrated and collected. Even these contained particles mostly of quartz but some of them showed whitish, yellowlish, reddish, brownish and amethystine colour. Besides the minerals, noted above, the following were also observed.

An irregular brown prismatic section, decidedly pleochroic and with an extinction angle of 19° is of hornblende. Prismatic or irregular section of orthoclase, altered to a varying degree and showing turbidity, are also present. An irregularly oval section, copper-red in colour, with very high refractive index and straight extinction, is of rutile.

It was observed that most of the black grains present in the sand-rock prove to be of magnetite. It may be noted that some patches of magnetite under high power show minute inclusions of biotite and felspar. It is interesting to observe that in these inclusions of biotite and felspar dendritic growths of magnetite are to be observed. But it is noteworthy, that these minerals occur only as impurities in the quartz sand, some of which reveal themselves only under very high power.

Sieve Analyses of Glass Sand

The following table gives the sieve analysis of a sample of this sand by standard I.M.M. sieves as used in the Glass Works at Jubbulpore. The sieves are arranged one over the other in the order shown below:

Retained on	40 mesh sieve	24·18
,,	60 ,, ,, ...	28·96
,,	80 ,, ,, ...	33·50
,,	100 ,, ,, ...	6·82
,,	120 ,, ,, ...	2·81
,,	150 ,, ,, ...	1·29
Passed through	150 ,, ,, ...	1·57
	Total	99·13

Chemical Composition

The chemical composition of the glass sand is represented by analyses No. I and II in the following table:—

	Jubbulpore Sands		Bargarh Sand	Sawai Madhupur Sand
	I (Tata Laboratories)	II (Mukerji & Drane)	III (Mukerji & Drane)	IV (Mukerji & Drane)
SiO_2	97·08	98·04	97·69	98·44
Fe_2O_3	0·85	0·14	0·04	0·33
Al_2O_3	0·87	0·91	1·72	1·17
CaO	0·40	trace	0·28	0·09
MgO	trace	0·09	trace	trace
Na_2O } K_2O	0·30	...	...	...
TiO_2	...	0·63	...	...
Loss on ignition	0·30	...	0·54	0·43
Total	99·80	99·81	100·27	100·46

Analysis No. I is of the sand which is used in the coke ovens of Tatas, etc. Analysis No. II is

of the glass sand and is quite satisfactory. The silica content is 98·04 with an iron content of 0·14 per cent. The sand is already being used for the production of varied type of articles, but it is suggested that the washing of the sand should be more thorough specially in view of its high iron content; as this operation will not only remove the objectionable clayey matter adhered to the sand grains but will also reduce its iron content.

MEDICINE AND PUBLIC HEALTH

PREVENTION OF JAUNDICE

A "PILOT EXPERIMENT" suggesting that artificial sunlight may be the weapon for fighting the danger of jaundice in persons who get human blood serum for transfusions or protective inoculations is reported in the *Science News Letter*, September 11, 1943.

The problem caused national concern in U. S. A. last year when more than 28,000 soldiers developed jaundice following inoculations against yellow fever. The army solved the problem by switching to another type of anti-yellow fever vaccine which does not contain human blood serum. So far as known this new vaccine has not produced jaundice.

If the findings of the Public Health Service pilot experiment are confirmed by further tests, the danger of jaundice following transfusions might be averted by passing the blood or serum for the big transfusion banks in a thin stream through artificial sunlight. For smaller quantities of human serum, used to prepare vaccines against disease, advantage might be taken of the fact that about two and one-half months after a person has had this jaundice, the disease-producing agent disappears from his blood.

The cause of the disease is believed to be a virus but so far scientists have been unable to identify it, or to give the disease to laboratory animals. For the Public Health Service studies, 189 persons volunteered to get the disease so that their blood could be used to learn more about it. Most of them had only mild attacks and all recovered.

FOOD SHORTAGE SOLVED IN THE LABORATORY

With a lump sum grant of $24,300 from the Rockefeller Foundation, the Massachussetts Institute of Technology conducted, during the last three years, some far-reaching experiments on diet in their attempts "to pack the utmost of nutritional value into the minimum of food bulk and at the least cost."

Though numerous experiments, under the direction of Dr Robert S. Harris, were carried out first with animals and then with human volunteers, the Institute developed formulae which concentrated into a 1½ pound package of food all the daily requirements for one individual in proteins, calories, vitamins and minerals. With this concentrate as a base, the nutritional biochemists have been able to work out special food problems for several government agencies, including the Army, the Navy, the Merchant Marines and the Federal Surplus Commodities Corporation. Among the problems studied are rations for submarine crews, life-boat rations, and emergency rations for pilots and soldiers detached from the home base. Packaged food concentrates for dropping from aircraft have also been developed. Both Russian and British representatives tested the concentrated food, and certain shipments of it have been made to these countries. These concentrates, made of dried meat, cereals, milk powder, yeast, dried vegetables and seasoning, were also used by members of Admiral Byrd's polar expedition. Dr Harris and his laboratory workers lived on this food, which cost only 6 cents a day, for weeks. They did not grew fat, but they remained in perfect health. This was made in the form of cereal flakes and tested by one dozen business men of Boston for 5 weeks with excellent results.

Food surveys in America showed that in order to obtain the recommended quantities of meat, eggs, fruits, vegetables and milk, an expenditure of from $2·5 to $9 per person per week was needed, and the bulk of families with three or more members could not afford this. Hence, some cheap-cost food concentrate was needed for the poorer class of the civil population. A concentrate, containing skim milk powder, corn germ powder or peanut flower, soya flour and powdered peas, along with pepper, salt, vitamins and minerals, was prepared, one ounce of which supplied all the vitamins and minerals needed for the body, plus 1/6th of the protein requirements and 1/20th of the caloric requirements, at a cost of

2·3 cents per serving in the form of soup. It was noticed that equivalent nutrition, not fully reliable, from natural foods would cost more than 25 cents, or above ten times the price of the laboratory-prepared food. This investigators wanted to see if the soup concentrate added to the conventional home diet would correct the ordinary deficiency diseases and safeguard against their recurrence. This was tested on 760 school children in Michigan and among industrial workers. The results so far obtained are encouraging.

The above experiments are of enormous significance to India, where the population is increasing every year and agriculture is in a quandary. Does India, under these circumstances, desire to utilise the help of scientists to solve the food problem?

THE MYSTERIES OF DUST*

K. N. BAGCHI,

CHEMICAL EXAMINER TO THE GOVT. OF BENGAL, CALCUTTA

IN the beginning of the last century the Scottish ministrel sang that the man whose 'soul so dead' as not to love his 'native land'

> "shall go down
> To the vile dust, from whence he sprung,
> Unwept, unhonoured and unsung."

Little did he realise in those days the extent of vileness of the dust now revealed by science. To the scientist it is not the simple noxious material with which are made that class of mortals whom the poet described in his inimitable verses, but it is a mysterious substance fraught with possibilities for an unlimited amount of harm to all mortals who have to struggle hard for existence.

So much work has lately been done on dust to study its physical, chemical, bacteriological and toxicological aspects that it is not possible for me to do justice to this fascinating subject. I will, however, make an attempt to deal only with the chemical and toxicological aspects as related to industrial cities.

Dust and Civilisation

Civilisation goes hand in hand with industrialisation and production of dust is the greatest curse of industrialisation. "Every fire whether for the production of heat or of power, every grinding or rubbing action, and in general all mechanical function and industrial and constructional activity creates dust." As the incidence of diseases, other than specific occupational diseases, is greater among the industrial workers than the general population and as the expectancy of life of the industrial worker is less than that of other people, the study of dust has, therefore, engaged the most careful attention of the Public Health authorities in all civilised countries and has developed to form a very important branch of Public Health Science—the Industrial Hygiene.

Dust is considered to be "the greatest single industrial hazard". More workmen are incapacitated for duty because of exposure to dust than for any other cause. It has been recognised by the public health authorities that the diminution of the dust hazard in all trades will result in a corresponding diminution of morbidity and mortality from tuberculosis and other respiratory diseases.

Dust—their source, size and number

Dust normally present in the atmosphere are produced by the action of the winds, rain, variation in weather, etc. and by decomposition of vegetation and animal matter. They are also due to volcanoes and meteors. The nature of the normal dust varies, therefore, with the local geographical condition. Dusts which form the subject matter of this paper are accidentally present in the atmosphere and have come about through the development of civilisation. Broadly speaking, dusts are dispersions of solid particles in air. The particles vary in size from 150 microns (1/167 inch) to 0·5 micron (1/50,000 inch). Those particles which are capable of being inhaled and absorbed in the system, range between 0·5 micron and 10 microns (1/50,000 to 1/2500 inch). It has been calculated that in normal atmospheres, 97 per cent of outdoor dust-particles are less than 1 micron and practically no dust particles larger than 1·5 microns are found in uncontaminated outside air. On the other hand, all dust particles in an industrial establishment are usually larger than 1 micron. "Careful observation has shown that about 60 per cent of the dust particles present in an industrial environment range between 1 and 3 microns only and it is interesting to note that the particles of silica dust isolated by postmortem examination from the lungs of the

* A lecture delivered before the Rotary Club, Calcutta, on 2nd November, 1943.

victims of silicosis also range between 1 and 3 microns." Apart from the size of the particles, the amount of dust present in the air is also important from the public health point of view, for it has been ascertained that the more intensive the exposure to dust, the more rapid is the development of the specific disease. The atmosphere of an industrial establishment, specially the indoor air, usually contains over 20 million dust particles per cubic foot of air while the outdoor air contains about 5 million.

As dust particles vary considerably in size and weight, the time they take for settling down varies very much. The largest or heaviest particles settle down quickly, while the smallest and lightest ones take the longest time ; and the longer the duration of their suspension in air, the further the distance they travel before settling down finally. This is the reason why dusts of heavy metals such as lead, mercury, barium, etc., are mostly confined to the neighbourhood where they are produced, while dusts containing soot, tar, compounds of arsenic and sulphur, silicates etc., are carried by the currents of air to places far away from the source. In this connection, it may be recalled how the fine dusts produced by the eruption of a volcano in Nicaragua in Mexico could be detected at Kingston in Jamaica—a distance of about 700 miles which the dust travelled through an upper air current in about 4 days. Similarly, the eruption of Krakatoa, another volcano near Java, produced such a fine dust that it remained suspended in air for about 3 years and could be detected in places several hundred miles away. It is, therefore, evident that fine dusts, including those which are very toxic, are likely to affect the population extending over a wide area.

The Classification of dust

Dusts have been classified in various ways but the classification of Dr Sayers, according to their chemical and physiological effects, is the best and is as follows :—

A. Inorganic dusts—
  (1) Toxic and/or irritant dusts.
  (2) Fibrosis-producing dusts.
  (3) Non-fibrosis-producing dusts.

B. Organic dusts—
  (1) Non-living organic dusts.
    (*a*) Toxic and/or irritant dusts.
    (*b*) Allergic dusts.
  (2) Living organic dusts.
    (*a*) Bacteria.
    (*b*) Fungi.

Inorganic Dusts

Toxic and irritant Dusts :—They produce deleterious effects, both general and local, on the human system. Those producing local symptoms are usually known as irritants and those producing general symptomps, that is, producing the effects after their absorption in the blood, are termed toxic. The toxic dusts are inherently toxic when inhaled, ingested or otherwise absorbed and include the dusts from heavy metals and their salts such as, lead, mercury, barium, zinc, etc. The oxides and carbonate of lead used as paints for doors, windows, etc., and yellow lead chromate as colour wash for buildings, are the most widely prevalent poisonous dusts. They are set free into the atmosphere not only from the factories where they are manufactured but also from the exterior of the buildings and other structures, due to the crumbling action of the weather. They are readily absorbed through the respiratory passages and produce chronic lead poisoning. Incidentally, it may be mentioned here that in a Hindu household where vermilion adulterated with read lead is used by the womenfolk, the atmosphere there is always charged with this lead compound and thus becomes a potent source of danger of lead poisoning among all the members of the family. Similarly, the arsenic-bearing dusts formed during the manufacture of paints, dyes, insecticides, fungicides, rat-poison, weed-killer and drugs are absorbed and produce chronic arsenic poisoning. Inhalation of zinc oxide during its manufacture produces what is called "metal-fume fever".

Quick-lime, lime, dichromates, etc., form irritant dusts and cause inflammatory lesions in the lungs.

Fibrosis-producing dusts.—Fibrosis is the development of fibrous or scar tissue as a result of inflammation, acute or chronic, caused by irritant substances, such as fine dust from sand, coal, iron, tin and other metals and also from asbestos.

The inhalation of these dusts produces what is called 'pneumokoniosis' or "Dust Disease of the Lung". The most important are siliceous dusts of granite, quartz, sand, pumice, slate, etc., which produce "silicosis"—a widely known disease among the workers in mines and quarries. Silicosis is also known as "miners' phthisis", particularly among the gold miners in South Africa. The condition similar to silicosis, produced by iron and other metal dusts, is known in medicine as "siderosis" and that produced by coal dust is called "anthracosis", while those engaged in the manufacture of asbestos articles develop an equally serious trouble termed "asbestosis". Some of these "Dust Diseases", particularly silicosis, are associated with the increased mortality rate from tuberculosis, pneumonia, pleurisy, etc. In fact, tuberculosis is liable to be a later development in certain forms of silicosis which, however, is not confined only to miners and potters but is met with in almost every industry in which steel and iron are used as raw materials. The possibility of silicosis

among these workers is due to the fact that "sand is used in the moulds and cores for metal castings and the dispersion of silica-dust from the sand" thus used is a concomitant feature of this industry.

Non-fibrosis-producing dusts:—These are harmless dusts. Neither they produce any toxic or irritant action nor cause any fibrous tissue to be formed. In out-of-the-way villages, where there are no industries, no metalled or tarred roads and no palatial buildings, the dusts are comparatively inocuous, but they act as carriers of bacteria all the same. In industries connected with limestone, plaster of Paris, gypsum, corundum, emery, etc., the dusts are also harmless.

Organic Dusts

Non-living organic dusts:—These contain carbon and are derived from animal or plant life as also from various chemical processes involved in the manufacture of dye-stuffs, explosives, drugs, textiles, etc.

(*a*) Toxic and irritant dusts.—They produce deleterious effects, both general and local, on the human system in the same way as described under inorganic dusts. The common irritant dusts are those of tar, soot, coal, tobacco, certain flours of cereals, and of fibres, such as wool, silk, cotton, jute, flax, etc. The toxic dusts are derived from certain chemical compounds which are extensively used as dye-stuffs, explosives, drugs, etc., *e.g.*, para-nitraniline, T.N.T., picric acid, nitro-naphthalene and other organic compounds. Many organic dusts produce dermatitis.

(*b*) Allergic dusts.—The term allergy is used to describe the condition of a peculiar inborn hypersensitiveness or susceptibility in which apparently inert substances produce characteristic manifestations particularly on the skin, and in the respiratory system. The allergic dusts consist usually of pollens of flowers, horse-hair, furs, feathers, cat's hair, certain kinds of pulverised wood, dusts from rice, oats and corn, and many drugs and other organic substances. The allergic manifestations on the skin are urticaria, eczema and purpura, *i.e.*, bleeding inside the skin resulting in purple or blue spots or patches, and those in the respiratory tract are attacks of asthma, hay-fever, paroxysmal attacks running from the nose and sneezing. These manifestations, particularly the attacks of asthma and urticaria, are interesting as they are frequently met with in susceptible persons after a meal of lobsters or crabs or after contact with a horse or a cat. In the latter condition, the smell, *i.e.*, the emanations from the animal, and not necessarily the hair of the animal, may also bring on the attacks.

Living organic dusts:—

(*a*) Bacteria.—The bacterial dusts are aggregates of bacteria, fresh or desiccated, suspended in atmosphere either as such or with ordinary dust particles. The most important bacteria are anthrax, tetanus, diphtheria, tuberculosis, small-pox, pus-forming organisms, etc.

(*b*) Fungi.—They are the mycelia or threads and spores of parasitic fungi. They may grow in the respiratory tract or in other parts of the body and thus cause discomfort if not serious illness.

Industrial Hygiene and the study of Dust

The study of dusts requires the services of physicists, chemists, bacteriologists and medical men with experience in public health work and the help of various kinds of complicated apparatus that have been invented for this purpose. The collection and identification of dusts and determination of their nature, size and number along with their physical, chemical and physiological properties form the various stages of such investigations and the data obtained therefrom form the basis of Industrial Hygiene—an applied science developed enormously quite lately to protect and improve the health of workers. To achieve this object numerous appliances have been devised and protective measures introduced to free the atmosphere of the industrial establishments from poisonous dusts as far as possible. A rapid development of Industrial Hygiene should, therefore, be aimed at to keep pace with the industrialisation of the country, otherwise the health of the workers would deteriorate and the establishments would suffer heavy loss by way of workmens' compensation and inefficiency of the workers due to ill health.

Calcutta or any other industrial city in India, is very backward industrially in comparison with any large city in Europe or in America. With the present state of her public health organisations having no schemes in view for developing Industrial Hygiene with necessary laboratories and scientific equipments for the study of the dust problem, Calcutta, or for the matter of that any industrial city in India, is at the present moment ill-equipped for rapid industrialisation. We might imagine what would have been the condition of our industrial workers and also of the general population if Calcutta had made the same progress industrially as she has made with respect to her size and population. Those who are in charge of planning post-war industrial expansion, should take note of these facts and proceed accordingly. Illiteracy and want of civic and sanitary consciousness as its corollary, would make the problem more difficult in this country. Dr Sayers, Chief of the U. S. Bureau of Mines, says that "the protection of the health of our workers is indeed an important health function and one which can be handled best through a govern-

mental agency co-operating with the employers and workers. Responsibility for safeguarding the health of industrial workers rests chiefly with State and local government."

Just to form an idea of an industrial city, as it is understood now, we might refer to New York City where "during a typical year there are discharged into the atmosphere 300,000 tons of soot, tar, cinders and fly-ash, and 350,000 tons of sulphur which form about 1,000,000 tons of sulphuric acid." It is needless to say that quite an appreciable amount of these noxious substances get into the system of the workers as well as of the people living outside, but on account of the higher standard of living, good health and increased power of resistance they are able to fight successfully against these heavy odds.

Dust—An Index of Industrialisation

One of the tables (Table I) included in the note, shows some analytical figures obtained by analysis in our laboratory of a few samples of dusts collected from different parts of Calcutta. They were very fine dusts deposited slowly on the tops of book-shelves, almirahs, electric casings on the ceiling, etc., and were absolutely free from any coarse or gritty particles usually found in the floor dust. The metals detected in these samples are partly of industrial origin and partly from other sources, *e.g.*, the traces of aluminium present there must have come from the soil, lead and arsenic from crumbled paints and colour wash and also to a certain extent from few industries in which they are used. Iron and zinc and perhaps calcium, are mostly of industrial origin and their comparatively high figures indicate some industrial activities in this direction possibly due to war efforts.

In Table II, the figures, showing only the inorganic poisonous constituents of dusts, taken from the Public Health reports of the City of Leeds, have been shown side by side with the corresponding figures for Calcutta dusts. They have been magnified for purposes of comparison by simple conversion from 'per cent basis' to 'parts per million basis'.

It is evident from the tables on the next column how Calcutta lags behind in the race for industrialisation. Lead, arsenic or copper is, of course, not the only criterion for judging the industrial development of a place but considering the variety of industries in which these metals are used one would not likely to be much far from the truth if these metals are taken, so to say, as yardsticks to measure the progress of industrialisation. Lead, for example, is used in as many as twenty important industries, all of which are essential for the production of what we call the amenities of modern civilised life. Dust may, therefore, be considered as an index of industrialisation or in other words of civilisation, just in the same way as consumption of sulphuric acid is claimed by chemists to be an index of civilisation or more familiarly, consumption of soap is claimed by ladies to serve the same purpose.

TABLE I

COMPOSITION OF CALCUTTA DUSTS

(Figures in percentage)

	Medical College	Amherst Street	Ballygunje Place	Shyambazar
Moisture	2·3	3·5	3·8	3·7
Soot, tar and other organic matters	19·0	26·5	25·8	24·7
Silica (as SiO_2)	52·0	49·0	56·0	46·8
Iron (as Fe_2O_3)	11·9	9·2	5·1	8·4
Aluminium (as Al_2O_3)	0·2	trace	trace	trace
Zinc (as ZnO)	1·5	0·2	Nil	trace
Calcium (as CaO)	9·6	11·1	8·0	15·0
Copper (as Cu)	Nil	Nil	Nil	Nil
Lead (as Pb)	0·0005	0·0017	0·00176	0·0041
Arsenic (as As_2O_3)	0·002	0·0006	0·0006	0·0014
Sulphur (as SO_4)	1·4	trace	trace	0·85
Ammonia (as N)	0·17	—	—	0·06
Chlorides (as Cl)	0·16	—	—	0·15

TABLE II

COMPARATIVE STATEMENT SHOWING DIFFERENCE IN COMPOSITION OF TOXIC DUSTS FOUND IN CALCUTTA AND IN LEEDS

(Figures in milligrammes per kilo.)

	Calcutta (1943)				Leeds (1936)	
	Medical College	Amherst Street	Ballygunje Place	Shyambazar	Industrial portion	Residential portion
Copper (as Cu)	Nil	Nil	Nil	Nil	410	Nil
Lead (as Pb)	5·0	17·0	17·6	41·0	3025	1725
Arsenic (as As_2O_3)	20·0	6·0	6·0	14·0	476	384

BOOK REVIEWS

Manometric Methods.—By Malcolm Dixon. Second Edition, 1943. Pages 150. Published by Cambridge University Press.

This book deals with methods, which have come into extensive use in biological investigations, for following reactions in which gas is either absorbed or given out. As a result of repeated attempts for studying the respiration of isolated tissues and of microorganisms, the enzymic oxidation and reduction and the progress of various chemical reactions ; a number of manomatric methods have been evolved by different workers. Dr Dixon, who has worked extensively with these methods of investigation, removed a long felt want by presenting to the scientific world a comprehensive and critical description of the various methods, by publishing the first edition of this book in 1933. In subsequent years considerable advance took place, specially, in the improvement and refinement of the methods and their application to an ever increasing varieties of problems. Several highly sensitive manometers for ultra-micro estimations by which exchange of gas of the order of one-millionth of a cubic centemeter can be measured, have been constructed. The present throughly revised edition, with many new additions recording the advance made, has added considerably to the value and usefulness of the volume. In Part I of the book an account is given of the construction and theory of the various types of manometer used, while Part II supplies guidance in detail for the use of the various methods which are now available. Workers in the field will feel grateful to the author for the clear description of the improved techniques and of the micromethods. The set of protocols of actual experiments will be very helpful to inexperienced workers.

B. B. S.

An Introduction to Industrial Psychology—By May Smith, M.A., D.Sc., Cassell & Co. Ltd., London. Price 7*s*. 6*d*. net.

To many in our country Industrial Psychology is still a mystery. Even those who ought to know better often naively ask how can psychology be applied to industry ? To them, the book is an effective answer. It gives a broad survey of the scope of the subject and reveals the actual nature of the many individual and social psychological problems that inevitably arise whenever many people come to work together in factories and business houses. To the enthusiast, on the other hand, who believes that high grade performance by workers in standard tests and adequate environmental factors are the only conditions necessary for bringing about the millineum in industrial sphere, the book rightly serves as a warning. It draws attention to the erroneous assumption lying behind such beliefs. The total man is not just a sum of parts, Miss Smith insists again and again. Coming from one who herself has been a worker in this field for a number of years the caution should be borne in mind by all new comers.

The book does not give details of the many tests, methods of applications, etc, and therefore cannot be recommended as a text-book. Still one would be well advised to go through it before beginning a serious study of Industrial Psychology. Laymen as well as would be specialists would both be benefited by a perusal of the book.

S. C. M.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*

A MILDEW ON JUTE

IN November 1942, a mildew was observed on jute specially grown in winter for crossing work. It remained on the crop up to the end of February. In August 1943, it was noticed on the main crop which was raised during the monsoon. The symptoms on this crop are not prominent as only a few greyish or whitish patches appear on the stem and very scarcely on the leaves. On the winter crop however, prominent patches of mildew appear on the upper surface of the leaves. They coalesce and cover up the entire lamina (Fig. 1*a*). When the infection is extensive,

FIG. 1 (*a*). Leaf showing the powdery mildew

the lower surfaces of leaves also get covered with the mycelium. In severe cases the attacked leaves become crinkled. Unlike the monsoon season, during the winter the leaves are first infected and then the stem. The entire stem, flower-bearing branches and capsules (fig. 1*b*) are ultimately affected. The fungus appears on the petiole, stipule, and axillary leaves as well. The attack is superficial and if the fungus is scraped off from the seat of infection only a slight discolouration is seen. Both *C. capsularis* and *C. olitorius* recorded the infection but the disease was considerably more in the former. Wild jutes, *C. acutangulus* and *C. fascicularis*, did not show any infection.

FIG. 1 (*b*). Stem and flower bearing branches with capsules showing the powdery mildew.

The fungus forms extensive network on all the above-ground parts. The network consists of hyaline and septate hyphae ranging in diameter from $2{\cdot}9\ \mu$ to $7{\cdot}8\ \mu$ which send out numerous upright conidiophores whose size and shape vary. They are either long and slender or short and stout measuring from $70{\cdot}0\ \mu$ to $140{\cdot}0\ \mu$, the average being $94{\cdot}5\ \mu$. From the end of these, hyaline, elliptical smooth 1-celled conidia arise in basipetal succession often in chains of two or more. The size of conidia varies greatly and the frequency array of measurements of 300 conidia is given in Table I. The range of variation

in length is very large but is not much in width. On an average they measure 33·0 μ by 17·4 μ.

TABLE I

MEASUREMENTS OF CONIDIA OF *Oidium sp* ON *Corchorus capsularis*

Length		Diameter	
Classes in μ	frequency	Classes in μ	frequency
21·5 to 25·5	1	13·0 to 15·5	15
25·6 to 29·6	44	15·6 to 18·1	267
29·7 to 33·7	60	18·2 to 20·7	10
33·8 to 37·8	189	20·8 to 23·3	8
37·9 to 41·9	5		
42·0 to 46·0	0		
46·1 to 50·1	0		
50·2 to 54·2	1		

The conidia have been seen to germinate readily in water.

No perithecia have been seen to occur on the host.

From the foregoing descriptions, the fungus may tentatively be named as *Oidium* sp on *Corchorus capsularis* and *C. olitorius*. On perusal of literature the occurrence of this mildew on this important host appears to be the first of its kind. Both Solomon[1] and Blumer[2] do not record occurrence of any mildew on any genus in the family *Tiliaceae*.

B. S. VARADA RAJAN.

Jute Agricultural Research Laboratories,
Tejgaon, Dacca,
11-11-1943.

[1] Solomon, E. S., A monograph of the Erysiphaceae. *Mem. Torrey Bot. Club*, 9, 1–292, 1900.
[2] Blumer, S., *Die Erysiphaceen*, Mittel europas Zurich, 1933.

TRAMETES FLOCCOSUS BRES. IN CULTURE

Trametes floccosus is a member of the family Polyporaceae. It was first collected by Murrill in Mexico in 1910 and described as *Ganodermus areolatus*[1] which is a synonym of the species. It was also collected from Africa and was described as *Fomes introstuppeus* by Hennings. The species had been collected from Ceylon and identified as *Formes floccosus* by Lloyd[2] who regarded it as synonymous with *Polyporus levisissimus*. Lloyd later on referred it correctly to the genus *Trametes*.

The fungus is widely distributed all over the tropics. It is common in tropical America including Mexico and Guatemala. It also occurs in Central and East Africa (Kenya), Ceylon and India (including Bengal, Bombay and Madras) extending upto north Australia. Bose[3] first reported its occurrence from Bengal.

Fresh sporophores of *T. floccosus* were collected in large numbers from living and dead tree trunks of *Ficus religiosa* Linn. from Calcutta, in July, 1942. Spore-deposits from such a sporophore were taken on sterile agar plates in the usual way. The spores were then transferred aseptically to culture tubes (6″ × ½″) containing potato-dextrose agar prepared by Fritz's method.[4] Growth in all cases started within 24 hours and several appressed and colourless mycelia were soon obtained. These cultures were kept exposed to the diffused light of the laboratory at the ordinary room temperature.

The initial growth was rather slow and the superficial mycelium soon produced a sub-felty to felty mat with narrow, appressed and sodden advancing zones. In 15 days after inoculation, the mat in all cases invariably became felty but the character of the zone of advance was not altered. About this time the slants were completely covered and the surface of the mat, due to irregular condensation, became slightly uneven. In 30-days-old cultures the mat became much condensed but remained felty throughout. The colour of the mat was mostly white but towards the upper advancing zone, shades of pale yellow orange[5] and pale ochraceous salmon appeared in patches. Gradually a lump was formed over the inoculum showing a resupinate patch of fruit-body with minute pore mouths (fig. 1). The

FIG. 1. *T. Floccosus* in culture showing fructification at the centre.

porous surface at first appeared pure white but later gradually acquired a tinge of lighter shade of light buff. Similar fruit-bodies were also obtained in other culture tubes. The pores on the hymenial surface in some culture tubes became slightly irregular depending on the irregular nature of the growth.

Such a fruit-body, on section, showed the presence of numerous basidia with basidiospores and a

few cystidia. The basidiospores are narrow, elliptical, hyaline, smooth walled and measure 12-14$\mu \times 6\mu$. From one of the fruit-bodies obtained in culture spore-deposits were subsequently obtained from which new polysporous cultures were made in the usual way. Three such cultures also fructified in about a month.

For making wood-block-cultures a normal and healthy piece of wood of *Ficus religiosa*, a natural host of the fungus was cut into convenient numbered blocks ($3'' \times \frac{3}{4}'' \times \frac{3}{4}''$). The dry weights of these were determined in the following way. The blocks were placed inside a hot air oven at 45°-50°C for 24 hours. These were then taken out, cooled, separetly weighed and replaced in the oven. This process was repeated for several days till they attained a final constant weight. The blocks were subsequently soaked in distilled water for about an hour. Prolonged soaking was purposely avoided in order to prevent soluble substances from being leached out and thus rendering the blocks poorer in nutrient content. After soaking, the blocks were placed in Roux tubes with some water at the base, care being taken that the blocks were not in direct contact with the water below. The tubes were then plugged and autoclaved at 15 lbs. pressure for 20 minutes. An inoculum containing 4-days-old mycelium of the fungus was put aseptically on the upper cross-sectional end of each block and tubes placed under similar conditions as stated above.

The growth was at first rather slow but later on copious vegetative growth covered the external surface of the wood-blocks. None of the cultures have as yet fructified on wood.

Observations are now being made on the loss of weight of the wood due to fungal attack in 4 months, specific action of the fungus on the wood and the type of rot produced, the results of which will be communicated later on.

Our sincere thanks are due to Prof. S. P. Agharkar, Head of the Dept., for the facilities given.

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BIMAL KUMAR BAKSHI

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Calcutta University,
Calcutta, 9-12-1943.

[1] Lloyd, C. G., Mycological Notes, No. 64, p. 1010; No. 65, p. 1092; No. 72, p. 1291; Cincinnati, Ohio, 1920-24.

[2] ———. Index of the Mycological Writings. Synopsis of the genus *Fomes*, p. 220, Cincinnati, Ohio, 1915.

[3] Bose, S. R., Polyporaceae of Bengal, Part IV, *Bull. Carmichael Med. Coll.*, Belgachia, 1921.

[4] Fritz, C. W., Cultural criteria for the distinction of wood-destroying fungi. *Trans. Roy. Soc. of Canada*, 17, 3rd Ser., 1923.

[5] Ridgway, R., Colour standard and colour nomenclature, Washington, 1912.

ZONES OF PROGRESSIVE REGIONAL METAMORPHISM AROUND TISTA VALLEY, DARJEELING DISTRICT

THE Tista valley in the Darjeeling district lying between the hill region of Takdah, Giele and Peshoke to the west and that of Kalimpong to the east, is occupied by low grade slates, phyllites and schists of pelitic and greywackish composition. They belong to the Daling series of Mallet.[1]

Up the hill slopes both to the east and the west the low grade schists etc. pass into progressively more metamorphosed schists and gneisses.

Five distinct zones of progressive metamorphism, essentially regional in nature, can be recognized and mapped within the metamorphic series, *viz.*, a chlorite, a biotite, a garnet, a kyanite and a sillimanite zone, disposed as shown in the sketch map. The Daling—Darjeeling Gneiss boundary of Mallet (*op. cit*) runs within our kyanite zone.

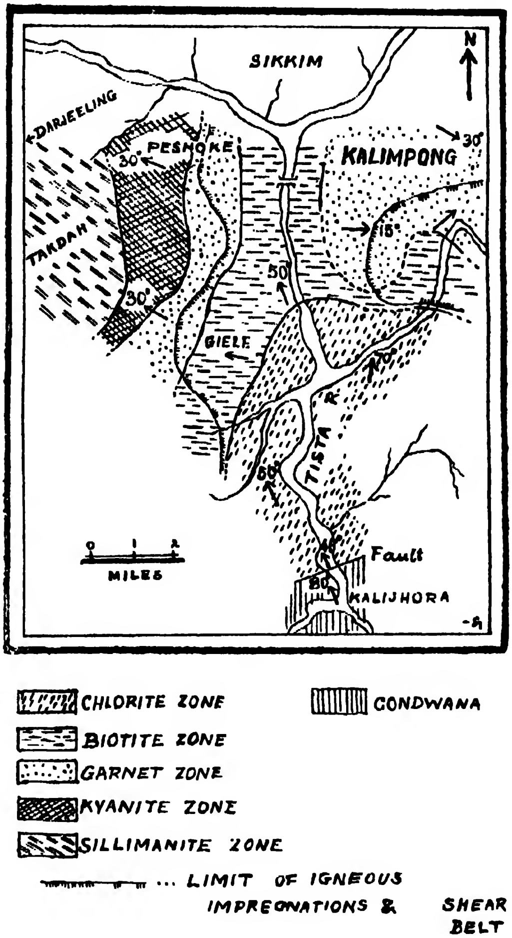

FIG. 1. Zones of Progressive Regional Metamorphism around Tista Valley, Darjeeling District.

The four isogradic lines bounding the five zones have been traced from the first appearance of the index minerals, biotite, garnet, kyanite and sillimanite. For this purpose pelitic schists only have been taken into consideration and microscopic examination of rock slides was always necessary; field observation often fails to reveal the index minerals. Greater precision in mapping the zones can be, therefore, attained by examining specimens taken at closer intervals across the width of the zones.

The staurolite isograd is not a separate line here. Although widespread and abundant, particularly in the Peshoke spur, staurolite is always accompanied by kyanite or/and sillimanite. The staurolite zone is here missing; the kyanite zone containing abundant staurolite, comes directly against the garnet zone.

The higher zones, from the sillimanite zone to a portion of the garnet zone, have been impregnated with quartzo-felspathic magmatic fluids and tourmalinisers. A line can be drawn (as shown in the map) demarcating the area of such impregnations from the area free from them; the line runs within the garnet zone and partly within the biotite zone. Along this line there is evidence of more localised and concentrated igneous activity. The schists occurring here show at the same time some characteristics attributable doubtfully to shearing; evidences are, however, yet inconclusive regarding positive existence of a shear or a thrust belt.

The five zones here have all the characters of corresponding zones of Barrow and Tilley.[2]

In the sillimanite zone near Takdah occurrence together of sillimanite, kyanite and staurolite in the same rock slide has been noted. This recalls the occurrence together of sillimanite and kyanite from some rocks of Ghoom and the Nepal frontier in the Darjeeling Hills.[3]

Some interest attaches also to the low grade greywacke-schists, which show, sometimes even in the garnet zone, signs of deformation by stress, such as retrogression of biotite and garnet to chlorite and granulation of albite porphyroblasts. Such effects are widespread and regional rather than local.

Detailed account of the rocks and their metamorphic and structural peculiarities will be discussed elsewhere.

S. Ray

Geology Department,
Presidency College,
Calcutta, 23-12-43.

[1] Mallet, F. R. *Mem. Geol. Surv. Ind.*, *11*, 1-96, 1874.
[2] Barrow, G.—*Proc. Geol. Assoc.*, *23*, 274-90, 1912; Tilley, C. E.—*Q. J. Geol. Soc.*, *71*, 100, 1925.
[3] Ray, S. K. *Q. J. Geol. Min. Met. Soc. Ind.*, *7*, 32, 1935, Pl. IV, Fig. 1.

TEMPERATURE OF THE SOLAR REVERSING LAYER

It is well known that molecules exist in the reversing layer of the sun and that they give rise to band spectra. Determinations of the relative intensities of the lines in these bands furnish valuable information regarding the physical conditions in the reversing layer. In recent years there have been several investigations in this direction. But many of these are only of a qualitative nature. The Cynogen band at λ 3883 is very well suited for such studies. The relations that exist between the temperature of a diatomic gas in thermal equilibrium, the molecular constants and the relative intensities of the rotational lines have been applied for determining the temperature of the reversing layer. The earliest investigation was that of Birge.[1] His determination was only from a visual comparison of the intensity distribution in the Fraunhofer Cynogen lines with those in the arc and furnace spectra obtained in the laboratory. From a knowledge of the temperatures of these terrestrial sources, he estimated the temperature of the reversing layer as about 4000°K. Later Roach[2] using Rowland Intensities arrived at a value of 5630°K. More recently Leon Blitzer[3] for the first time attempted a quantitative study of the intensities of the lines in this band and obtained a value of 4500°K. He photographed the solar spectrum with the 75-foot tower telescope of Mt. Wilson having a linear dispersion of 3mm. per Angstrom. But his exposures for the solar spectrum were unusually long ranging from 40 minutes to 4 hours. During such long intervals the sky conditions will never be constant and it is very necessary that plates intended for photometric work should be taken under constant sky conditions particularly to avoid the uncertain influence of the varying sky conditions. Since investigations of this nature provide valuable observational material for an analysis of the physical state of the solar atmosphere, spectrograms covering the region of the CN band at λ 3883 were secured by the author at the Kodaikanal Observatory during the last ten months and from the large number of plates available, only those of the finest quality were finally selected for photometry. The spectra were secured with a glass Littrow Spectrograph giving a linear dispersion of about 2·5 mm. per Angstrom in this region. Exposures of 1 to 2 minutes were sufficient to give good pictures. The instrument is designed to minimise the systematic errors due to the scattered light in the spectrograph. Standards were impressed on each plate by a step slit. The intensities of the band lines were measured from microphotometer tracings using for this purpose the Cambridge Photoelectric Microphotometer.

It is seen from the theory of the band spectra that measurements of the position of the maximum

intensity in a band should be an excellent method for determining stellar temperatures and it can be shown that for the CN band $J_{max} = 0.434\sqrt{T}$ where 'T' is the temperature. From the photometry of this band it is found that J_{max} falls in the vicinity of 31 giving the excitation temperature in the reversing layer as 5100°K.

This result has been confirmed by an alternative method of calculation. It can be shown that "log $^{I}/_{i}$" (where 'I' is the intensity and 'i' the relative intensity factor of the rotational line) when plotted against "J. (J+1)" gives a straight line the slope of which involves 'T'. A least squares solution was made to determine the straight line and a value of T=4960 ± 100°K was obtained.

A detailed paper embodying these results will be published shortly elsewhere.

K. NARAHARI RAO.

Solar Physics Observatory,
Kodaikanal, 24-12-1943.

[1] Birge, *A. P. J.*, *55*, 273, 1922.
[2] Roach, *A. P. J.*; *89*. 99, 1939.
[3] Leon Blitzer, *A. P. J.*, *91*, 421, 1940.

A COMPARISON OF THE LIMB AND DISC SPECTRA OF THE SUN

IN the above note the author has described investigations undertaken for determining the excitation temperature of the solar reversing layer from a study of the intensity distribution of the CN band at λ 3883. A value of about 5000°K was obtained for the temperature of the layers at the centre of the sun's disc. It was reported by Miss M.G. Adam[1] that her investigations on the intensity distribution in the C_2 band at λ5165 at the centre and the limb of the sun yielded a higher temperature for the layers at the limb than those at the centre. In order to examine this rather novel result obtained by Adam the writer has studied the CN band at λ 3883 with a hope of clarifying the situation. A number of limb spectra have been obtained with the high dispersion spectrograph used in the previous investigation when the seeing was 5-7 on a scale of 1-10. The plates were all calibrated from the characteristic curves. A range of intensity values were obtained for each plate which includes the limb and disc spectra. The temperature has been determined from the slope of the curve drawn between log(I/i) and J(J+1) as described in the previous note. It is found that the limb temperature is in all cases definitely lower than the disc temperature, T_{limb} being 4500 ± 100°K.

We may in this connection recall the interesting observation of Hale and Adams[2] *viz.*, ". . . . Carbon and Cynogen are particularly interesting (or a comparison of the spectra of the limb and the centre of the sun). Many lines in the violet carbon band are of unchanged intensity, or perhaps slightly strengthened, at the limb. The Cynogen fluting, which begins at λ 3884 is, on the contrary, very decidedly weakened at the limb. . . ."

It is possible that the strengthening of the carbon band lines at the limb observed by Miss Adam is not due to the higher limb temperature but to some other cause. With a view to investigate this apparent anomaly, further investigation is in progress particularly as regards the relative intensities of the CH and the C_2 bands in the laboratory and solar spectra.

K. NARAHARI RAO.

Solar Physics Observatory,
Kodaikanal, 24-12-1943.

[1] Adam, M. G., *R. A. S. Monthly Notices*, *98*, 546, 1937-38.
[2] George E. Hale and Walter S. Adams, *A. P. J.*, *25*, 310, 1907.

ABSCORBIC ACID CONTENT OF CHINESE ROSE HIPS

IT has been shown by Wang[1] that in 100 out of 108 healthy persons examined, the plasma ascorbic acid content was below 0·4 mg. per 100 c.c. with an average of 0·19 mg. per cent. Wang and Liao[2] reported the nutritional status with regard to ascorbic acid of Chungking School children in different seasons of the whole year. It was found that in 35, 65 and 4 per cent of the children in spring, autumn and winter respectively the urinary excretion of ascorbic acid never reached the saturation level on the second day after administration of the test dose. Wang[3] found that in 79 per cent cases the content of ascorbic acid in breast milk was below 4 mg. per cent. This is considered to be too low to supply sufficient ascorbic acid to meet the babies' daily requirements. From the above it is clear that most of the Chinese diets are deficient in ascorbic acid. Therefore the remedy for this defect is quite an urgent problem in China, although in winter months there is sufficient supply of citrus fruits in the south-east and the south-west provinces of China.

In this letter are given the results of analyses of the ascorbic acid content of rose hips which constitute the richest source of ascorbic acid in Chinese foods.

1. *Collection and preparation.*—The rose hips were collected from the sides of fields and roads and the slopes of the hills in the region of Kolo-shan, Chungking and some other places of south-west provinces of China, at the end of August. The colour of hips varied greatly from green to yellow according to the degree of ripening. After the inedible portion had been removed, the edible portion was washed with distilled water and then dried in the air.

2. *Determination of Ascorbic acid.*—1-2 grams of fresh rose hips (E.P.) were ground in a mortar with a little acid-washed sand and 5 c.c. of 4 per cent metaphosphoric acid solution. The fine paste was poured and washed with 10 c.c. of dilute metaphosphoric acid into a centrifuge tube and centrifuged for 10 minutes. The supernatant liquid was transferred to a cylinder. The precipitate was washed three times with 15 c.c. of 4 per cent metaphosphoric acid each time. The washings and the first extract were combined and diluted to a total volume of 80 c.c. with 4 per cent metaphosphoric acid solution. The ascorbic acid content of the extract was determined by the usual titration method using 2 :6 dichlorophenol indophenol.

TABLE I

ASCORBIC ACID CONTENT OF CHINESE ROSE HIPS (mg./g)

	colour of fruits.	
Sample No.	green	yellow
1	12·61	22·23
2	15·53	22·50
3	16·89	22·60
4	17·00	23·15
5	18·01	23·42
6	19·52	25·08
7	19·25	25·61
8	20·00	25·89
9	20·10	26·50
10	20·39	26·52
Average	17·93	24·35

3. *Results and Discussion.*—The results are shown in table I. It will be seen that the ascorbic acid content of rose hips varied greatly with the degree of ripening. The green hips contain ascorbic acid from 12·61 to 20·39 mg. per gram with an average of 17·93 mg. per gram, while the yellow ones contain 22·23—26·52 mg. per gram with an average of 24·35 mg. per gram. The average content of ascorbic acid of ripe rose hips is double that of the Emblic fruit.[4] A comparison with the usual rich sources of ascorbic acid such as Chinese citrus fruits and vegetables is given in Table II. It is 40

TABLE II

THE COMPARISON OF ASCORBIC ACID CONTENT OF ROSE HIPS AND CITRUS FRUITS AND OTHER VEGETABLES

Names	mg. per gram or per c.c.	Reference No.
Green hips	17·93	
Yellow hips	24·35	
Emblic fruits (green) ...	9·96	4
" " (yellow) ...	8·46	
Orange juice (Fu Chow) ...	0·70	
" " (Chung King)	0·56	
" " (Kuri Chow)	0·68	6
Tangerine juice (Chi-Kiang)	0·26	
" " (Fu Chow) ...	0·47	
" " (Wen Chow)	0·13	
Green Amaranth	1·17	7
Pea Sprout	1·04	

and 90 times more potent than the juices of orange and tangerine respectively, and about 20 times than of green amaranth. The rose hip, therefore, is the richest source of ascorbic acid among Chinese foods. It will easily meet the daily requirement if an adult weighing 60 kilograms can take one half of rose hip a day.[5] We strongly suggest that the authorities should make this fact known to the people for adopting it as food.

The ascorbic acid content of Chinese green and yellow rose hips was determined by the usual titration method using 2 :6 dichlorophenol indophenol as an indicator. The average content of ascorbic acid in green and yellow rose hips is 17·93 mg. and 24·35 mg. per gram respectively. It is about 2, 40 and 90 times higher than that of Emblic fruits, orange and tangerine juice respectively.

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26-12-43.

[1] Wang Cheng-Fa, The Chemical News leaflet, 6, 16, 1943. *J. Chinese Chem. Soc.*, 10, 45, 1943.
[2] Wang Cheng-Fa and Liao, Hsu-Chen, *J. Chinese Chem. Soc.* in press, 1943.
[3] Wang Cheng-Fa, unpublished data.
[4] Chen. T. M. Ho, S. Hsieh, K. M. and Shen, T., Biochem. Bulletin No. 27, 1943.
[5] Wang Chen-Fa, *J. Chinese Chem. Soc.*, 9, 97, 1942.
[6] Wang Cheng-Fa, unpublished results.
[7] Wang Cheng-Fa, *J. Chinese Chem. Soc.*, 9, 141, 1942.

FISH "GOING ON HOLIDAY"

In India, people now have realised the envigorating effect of a 'change'. So those who can afford it generally go out for a change to a health resort during vacations.

In Europe, people have gone deeper into the thing and almost everybody generally goes out annually for a change which goes by the name "going on holiday". Even labourers of factories get a leave for a fort-night annually for such a change. Experts of health are of opinion that even a change from one part of a city to another has the desired effect.

Now fish can also get the envigorating effect with a change. Even transference of fish from a big pond to a small one for a week may have the desired effect and more so on retransference to the big pond. This sort of change should be done for a week in every six months.

The effect of such change is found indirectly in rivers where fish generally get a change often as they migrate from one place to another, and for this reason their rate of growth in rivers is much more than in stagnant ponds.

We have also noted the envigorating effect of change even in small aquaria in the cases of small variety of fish, such as, *Barbus conchonious*, *Barbus ticto*, *Amblypharingodon mola* etc. This sort of change not only gives vigour but it gives a stimulus for ready spawning mostly in fish mentioned above. On transference of mature males and females of the fish during breeding season from ponds to small aquaria we have noted on several occasions in our laboratory the immediate starting of spawning.

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H. K. MOOKERJEE

Botany

Progress of Botany with Special Reference to Economic Plants

T. S. SABNIS

DURING the last three or four generations the progress made in improving the numerous plants and animals which provide us with food, clothing and ornament has been astounding. The progress achieved by the non-scientific methods in earlier centuries was no doubt good, but it could hardly have stood the strain of the modern political problems and helped to satisfy the industrial and commercial requirements of to-day.

The world was first made alive to the possibilities of the science of plant breeding by the work of Luther Burbank in the last decades of the last century. Since the year 1900, however, a fresh impetus was given to work on most of the cultivated plants all over the world. Whereas results of great economic importance were secured with wheat in America, England and India, and advances made in several other crops also, the work led to important findings of scientific interest as well.

Intensive work with selection and cross fertilization of indigenous material was followed by exploration of useful material in different parts of the world and new forms, possessing great resistance to diseases, frost and drought were introduced, specially in Russia and the United States of America. Along with the introduction of new plants has been going on the work of changing the existing forms by means of X-rays and ultra-violet rays.

Another development of botany has been plant ecology, that is, that branch of botany which deals with the effects which the various environmental factors produce upon plants. In dealing with the problem of controlling vegetation, either for agriculture, forestry or for the improvement of grassland, plant ecology, by investigating the fundamental laws concerning growth of plants in relation to the environmental factors, will be of much help.

Much attention has lately been paid to one of these factors, *viz.* light. By subjecting plants to controlled illumination, and sometimes, when necessary, by artificially giving them additional illumination, the growth periods of crops have been markedly changed, thus making possible certain breeding experiments. The information secured is, besides, useful to the agriculturist and the horticulturist in their attempts to grow plants in new environments, different from those to which the plants belong.

The study of response of plants to different temperatures has led to the process originated by Russian scientists and now known as vernalization, which consists of giving to the seeds certain temperature treatments. Vernalization has enabled Russia to luxuriant crops of winter wheat in areas in which it was formerly impossible to grow it successfully. Thus the process has enabled agriculturists to triumph over Nature's climatic barriers. A great deal of work in this direction is now being done in the different countries.

Another factor which stimulates plant growth resides in the plant itself but it was discovered only recently. It is known as the growth regulator and is something like the growth hormones of the animals in nature. Preparations of plant growth regulators are now being used for stimulating the rooting of plant cuttings or seedlings which are normally found difficult to be propagated.

Researches on the nutrition of plants have led to the discovery of the important role which some of the elements play in the life of most plants. These elements are required only in traces, yet they are essential. Their deficiency was at times responsible for failure of vast crops, but with the knowledge gained the crops can now be saved by supplying the deficiency.

Not the least important researches to increase the production of economic plants are those which deal with plant diseases. Much has been done in this direction by breeding resistant varieties of plants.

Chemistry

Some Aspects of Modern Inorganic Chemistry

R. C. RAY

WHEN Ramsay first isolated the rare gases of the atmosphere, it seemed that chemically they would be uninteresting because of their extreme chemical inertness. In recent years, however, a large variety of compounds of these inert gases has been prepared. To-day they have received not only various industrial applications and neon lights are blazing forth their messages in all the cities of the world, but also they have been of utmost importance in the development of chemical theories.

Theoretical considerations will show that the rule of zero valency cannot be strictly true for the inert gases. In the first place, each inert gas atom has four lone pairs of electrons so that it can act as donor atoms in the formation of the co-ordinate link. Secondly, as the maximum number of electrons possible in a quantum group of n is $2n^2$, it is evident that the third and higher groups in argon, krypton, xenon and radon are capable of expansion so that they might be expected to act as acceptors of electrons. Thirdly, when the inert gas atom is suitably excited, one or more electrons may be promoted to the higher quantum level ; in this state they will resemble a uni- or bi-valent element and compound formation may take place. All the three possible types of compounds have now been prepared. For example, the argon fluoborates ($A.\ BF_3$; $A.\ 2BF_3$ etc.,) of Booth and Willson, Nikitin's hexahydrates of neon and argon, and the helides of mercury, tungsten, sulphur, phosphorus etc., prepared by Manley, Boomer, Damianovich and others may be cited respectively as representatives of the three types. But little work in this line has been carried out in this country.

A large amount of research work has been carried out during the last 30 years in the chemistry of boron compounds. The pioneer work on boron hydrides has been done by Stock, Wiberg and their co-workers in Germany. An admirable summary of all the earlier work has been given by Stock in his Baker lectures which also contain a detailed description of the high-vacuum technique used in the isolation and manipulation of these highly reactive and volatile hydrides. Hydrides of boron described in literature may be divided into two classes of the general formulae B_nH_{n+4} and B_nH_{n+8}.

B_nH_{n+4} : B_2H_6, B_5H_9, B_6H_{10}, $B_{10}H_{14}$.

B_nH_{n+6} : B_4H_{10}, B_5H_{11}, B_6H_{12}.

They are all colourless substances, ranging in volatility from diborane, B_2H_6, which has a boiling point of $-92{\cdot}5^\circ$ to $B_{10}H_{14}$ which forms characteristic crystals melting at $99{\cdot}7^\circ$. Earlier work on boron hydrides has been extended by Schlesinger, Burg and others in America. They have discovered a new method of preparing diborane, by the action of hydrogen on boron trichloride (or tribromide) in a high-voltage electric discharge, and a large number of new reactions of diborane. Two of these reactions, namely, the action carbon monoxide on diborane and that of diborane on metal-alkyls resulting in the formation of borine carbonyl and metalloborohydrides respectively, are extremely interesting. The work of the American School of Chemists has been fully reviewed in the Chemical Reviews of 1942.

In this country Ray (R.C.) and his collaborators have carried out a considerable amount of work on the chemistry of boron. They have studied the mechanism of hydrolysis of magnesium boride and found that the first product of hydrolysis is a compound of the formula, $H_3B_2(Mg.OH)_3$ which on further hydrolysis gives the isomeric borohydrates of the composition, $H_6B_2O_2$. The $\alpha-H_6B_2O_2$ has been assigned the constitution

$$\begin{bmatrix} H : B : OH \\ :: \\ H : B : OH \end{bmatrix}^{2-} \begin{matrix} H^+ \\ \\ H^+ \end{matrix}$$

and the $\beta-H_6B_2O_2$ the constitution

$$\begin{bmatrix} H : B : OH \\ :: \\ HO : B : H \end{bmatrix}^{2-} \begin{matrix} H^+ \\ \\ H^+ \end{matrix}$$

Both the compounds liberate hydrogen by acids, but while the α-compound yields 4 atoms of hydrogen the β-compound liberates 2 atoms of hydrogen per molecule with the formation of

$$\begin{matrix} B : OH \\ :: \\ B : OH \end{matrix}$$

and

H : B : OH
:: respectively. In course of these in-
HO : B : H

vestigations, two lower oxides of boron, B_2O_2 and B_4O_5, have been isolated in the pure state. The oxides are both acidic and give rise to the acids, $H_4B_2O_4$ and $H_2B_4O_6$. The properties of these acids and their corresponding salts have been studied.

Sufficient has been said about the hydroborons and the borohydrates to indicate that a new field of research has been opened up in which there exists considerable scope for further experimental study. The work has revealed the limitations of our knowledge of the chemical bond, and it is evident that a full understanding of the structural chemistry of this group of compounds has not yet been reached. The relationships between structure and stability of these compounds are worthy of more detailed study. Further researches on boron compounds may lead to a fuller knowledge as to the nature of resonance and its relation to chemical bonds; and the preparation of more organic derivatives may also lead to a boron-organic chemistry comparable to that of numerous silicon-organic compounds; and there is no doubt that this new field of inorganic chemistry will attract investigators for many years to come.

In order to gain a clearer insight into the nature of the chemical bond more extensive investigations of co-ordination compounds, with a view to determine the factors which determine the co-ordination number of elements, are also of great importance. Although a considerable amount of research has centred round co-ordination compounds since the time of Werner with all the powerful physical methods at the disposal of the modern chemist, and old observations have been refurbished in the light of present-day knowledge, yet we are far from understanding fully the factors which determine co-ordination. Investigations of considerable interest and importance are being carried out in this country by Professor P. Ray and his school at the University College of Science, Calcutta.

Although the use of more powerful and exact methods are gradually advancing our knowledge of the course of many inorganic reactions and of the structure of inorganic compounds, a considerable ground still remains to be covered. While the structure of most organic compounds has been carefully worked out the same thing cannot be said about many inorganic compounds. A systematic study of these, using the tools placed at our disposal by the physical chemists, will yield fruitful results.

It will thus be seen that the future of inorganic chemistry is very bright indeed. It is evident from what has been said that a large amount of work still remains to be done on the compounds of the inert gases, compounds of boron, co-ordination compounds, structure of inorganic compounds, and the mechanism of inorganic chemical reactions and a combined attack of what were in former days separate "sciences" should be made on the various problems to produce the most prosperous harvest.

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POST-WAR EDUCATIONAL DEVELOPMENT IN INDIA

THE Central Advisory Board of Education has recently approved with some minor modifications the memorandum on post-war educational reconstruction prepared sometime ago by Mr John Sargent, Educational Adviser to the Government of India. The memorandum is said to be now under consideration by the Reconstruction Committee of the Central Government.

Though the memorandum has not yet been made public* we are more or less familiar with the outline of the scheme contained therein. In his presidential address before the Section on Psychology and Educational Science of the Science Congress this year at Delhi Mr Sargent gave an outline of the Scheme, and a brief notice of it appeared in these pages (*vide* SCIENCE AND CULTURE, February, 1944, p. 339).

Briefly the scheme intends to make the minimum provision for a national system of education for India, a provision which will bring her to an approximate level with other civilised countries of the world. There is nothing high-flown in the scheme as far as provision for different types of institutions is concerned. Rather it must be admitted that the computations on the basis of which the scheme has been framed have been rather modest than extravagant. India is a big country with a vast population and a national system which aspires to serve the educational needs of the different sections of the population of this vast area will naturally be of large dimensions. Even if we are only to make education compulsory for our children,—and we have been demanding this for so many years and no one will be satisfied with anything less than that—we shall require school accommodation for more than five crores of pupils. This is a pretty large number. Even then we shall not have provided for children below six or above fourteen. To give elementary education to these five crores of pupils we shall require at least eighteen lakhs of primary school teachers. And to provide a living wage, a wage which shall not certainly attract the best among our youngmen and women to the teaching profession but which, we hope, will attract at least the better among them, we shall require not less than one hundred and forty crores of rupees annually. Proceeding with moderation in the above manner, Mr Sargent has computed that when the whole scheme will be in operation it will require about three hundred crores per annum. And it will be forty years before the scheme can be put into operation in its entirety. (Some critics are impatient on this account; but they forget that the delay will have been mainly due to the fact that it is not possible to conjure up eighteen lakhs of trained teachers in one or two years or even one or two decades). At the present computation therefore, forty years hence India will be spending less than ten rupees per capita for education. When we remember that England today spends fifty-two shillings (about forty rupees) can we very well maintain that Mr Sargent has erred on the side of extravagance in preparing his scheme?

No, the difficulty is not there. We must realise once for all that we cannot have decent education without paying decently for it; and judging by all available standards it cannot be said that to spend three hundred crores of rupees for the education of a country with a population of about forty crores is by any means extravagant.

It would be fair to point out that the scheme envisages a very slow and gradual increase in the cost of education. It has been calculated that in the

* Meanwhile the Government of India have published for general information the full text of the report of the Central Advisory Board of Education, which was not available at the time of writing and a short note on which appears elsewhere in this issue.

first five years the approximate incidence of the increased cost would be about ten crores ; in ten years it would rise to Rs. 23 crores and in twenty years it would rise to Rs. 61 crores. The present cost of education comes to at little over rupees thirty-three crores.'

It would therefore appear that the financial implications of the scheme are not as absurd as they would at first appear. In fact as far as it goes the scheme is excellent. It perhaps too closely follows the English pattern but that need not go against it. Sooner or later we shall require a plan for the framework of a national system of education for this country and here we have one already to be put into operation. And we must congratulate and thank the Central Advisory Board and specially Mr Sargent for having given it to us. It is true that many of the details are still lacking in the scheme ; these details are still to be worked out. A national system of education must be based on national culture and it shall be national in outlook. How the present system is to be transformed in spirit to become truly national we have no idea of knowing from the outline of the framework as we have here. Nor can we guess from it how the present administrative machinery is to be changed to make it also national in outlook and spirit. But once the framework is ready these outlines and details will be developed ; and we know that the idea that inspired those who are responsible for the scheme was nothing more ambitious than to suggest to the country a framework for a national system and that is exactly what we have here. And as we have said there is nothing here one can find fault with.

We know that grave misgivings have been expressed in some quarters whether India can afford to finance a scheme which would require so much money. These critics feel that it is sure to founder on the rock of financial inadequacy. Others there are who have questioned if this is the proper time to speak of educational reconstruction. They think that to talk of reconstruction in the midst of war, famine and pestilence is to indulge merely in day-dreams. It may even be a way of escape from the grim realities of life, a means to distract our attention from real things around us.

We need not be pessimistic like this ; but we must clearly state the issues involved. The crux of the problem, to our mind, is not in the financial implications of the scheme ; it lies in the will to implement it. We believe that if only the will is there, nothing will be wanting ; not even if we increase our educational budget by a thousand per cent. If there is to be any doubt, it may legitimately be on this score. Is that *will* to do in evidence anywhere?

West of Suez, the Viceroy-designate of India fails to understand how people can find money to wage war and yet cannot find funds for education, the sole and certain remedy against war and the only sure foundation of peace ; and east of Suez, the Viceroy joins issues with those who fail to give education the first place in any scheme of national development. Education can wait, he says. Communications, must come, then health, and last, education. England had industrialisation long before she had a national system of education, it is argued, and India must follow the example of England even if it means committing all the foolish mistakes perpetrated by England. The Viceroy is not probably expected to be familiar with the history of education in England, but may we bring to the notice of His Excellency and his advisers the grim fact that as education did not keep pace with industrialisation, there was so much wastage of materials and human energy in that country? In fact, when in the closing years of the last century and the early years of the present century England was trying to lay the foundation of a national system of education for herself, her chief difficulty was to make up the lag between the material and moral evolution of the English society. That lag is yet to be made up. By raising the school-leaving age, by providing more amply for continued and adult education even today England is trying to do that.

Are we not to learn by England's mistakes? Are we to bring in industrialisation with all its attendant but preventable evils and then try to atone for them, say forty or fifty years hence? And, indeed, how will the industries be supplied with efficient and intelligent man power? In the meantime, who will build up the communications and look after the health of the nation—an illiterate and uneducated mass? Can we have any effective and safe industrialisation without the safeguard of a national system of education? Indeed, to argue that the production of wealth should be carried out first and then education can start is to forget the intimate interdependence between the two. It is true that the financing of an educational plan must ultimately depend upon the production of wealth but it is obvious that educated and trained workers themselves would be the first agencies for stepping up production without being driven like slaves. The Stakhanovite movement in the Soviet Union, which encourages workers to use their brains and invent better ways of production, has been a phenomenal success because it mobilises thousands of educated workers instead of leaving all the thinking to the relatively few engineers and supervisors. The fact of the matter is, education stimulates production both qualitatively and quantitatively, while the increased production pays for

more wide-spread education. Production of wealth and the spread of education have reciprocal relations.

"In the youth of the nation, we have our greatest national asset. . . . We cannot afford not to develop this asset to the greatest advantage". So says the White Paper and it outlines a scheme of post-war educational reconstruction for England. The statement is pregnant with a sense of futility of the old system and the determination to establish a new system which alone can build a new social order.

In India, is that determination to build a new social order in evidence anywhere, specially among those who hold the destiny of our country in their hands?

The reality is that a national system of education can be built up only by a free National Government. Once that Government comes into power there will be no difficulty to simultaneously industrialise the country and educate the youth of the nation. Russia has fully demonstrated the truth of this. To talk of a national system of education without a National Government is therefore unreal. This is the real issue involved and when we are now talking of educational reconstruction let us clearly realise this. One has only to remember the late Gopal Krishna Gokhale whose fiery advocacy for compulsory primary education requiring only modest finances was quenched by the cold shower of Delhi.

NEED FOR PERSONNEL RESEARCH IN INDIA*

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INDIA is a vast continent with abundance of raw materials, and a huge population of 400 millions of people pulsating in it. Men and materials are the primary bases upon which the very existence of Nations depend, and the proper utilisation of them constitutes the essence of national prosperity. India, over-equipped as she is with these primary resources, is awake now and is striving for attaining this prosperity, which she feels, she could have attained earlier had the resources been organised properly. Leaders of thought are taxing their brains, and formulating various plans and schemes for furthering the cause of national advancement. Economical security, mass education, industrial development, agricultural research and all the traditional constituents of national prosperity, figure prominently in these plannings. Physicists, chemists, and specialists of other objective sciences are found to have been entrusted with all responsibilities in these plannings. These scientists have undoubtedly made valuable contributions towards furthering the cause of human welfare, and the importance of the part they play in nation-building activities cannot be exaggerated. Without the least intention of minimising importance of the role played by these objective scientists I beg to raise a very simple question. Are these experts fully competent to tackle the two fundamental bases of national prosperity, I mean, men and materials with equal efficiency? The answer certainly would be in the negative. Their activity is exclusively in the sphere of raw materials, and their contributions to the cause of human happiness therefore, are always indirect. The direct and scientific utilisation of human materials is undeniably a contributory factor to national prosperity, but the problem does not come within the scope of the objective scientists and for that reason it seems to be completely overlooked by our countrymen. As a result of this inadvertence, the psychologist, who deals with the human materials exclusively, is found to be conspicuous by his absence from nation-building programmes where he ought to have a prominent place. In the present paper I shall discuss, the aim and scope of conducting researches in the field of scientific utilisation of human materials, describe similar activities in the leading countries of the East and the West, show their importance and utility, and finally demonstrate the necessity and practicability of such researches in India.

It has long been recognised that individuals differ vastly in respect of their talents and temperaments which fit or unfit them for the various avocations that their social system provides. There cannot be any two opinions on the point, that the work or avocation in which a man spends one half of his waking hours should if possible be such as he can perform

* Read before the Indian Science Congress, 1944.

successfully and happily. Yet the gravity of the problem of occupational misfit, the immensity of the total human suffering and economic loss resulting from unsuitability of employment, does not receive the attention it deserves. Of all the sources of friction and wastage in industry, commerce and other establishments, the employment of men and women in unsuitable tasks should unquestionably be given a place of very high importance. The psychologist, the only competent person to deal with the question of proper utilisation of human materials, has taken up in right earnest the task of preventing any further, the increase of the square pegs in the round holes, in various social systems. Since the last few decades the psychologists of foreign countries have been making serious attempts to discover the particular talents which make for success in the different walks of life, and the temperamental qualities which help or hinder the use of those talents. Valuable materials have accumulated as a result of these attempts, which of late have brought about an orientation in policy regarding selection of employees. It can be stated without any reservation now that non-scientific procedures and policies in matters of personnel selection are gradually receding in the background by giving place to the scientific methods as advocated by the psychologists. If we look at the activities of the foreign countries, the importance of psychologists in solving personnel problems, comes out in bold relief. There is rarely any country in the whole world now, which has not yet undertaken the task of conducting researches in personnel problems. Apart from the different universities where training is imparted or researches carried out on personnel problems, many organisations, official and non-official, are in existence, devoted to similar activities. In some places there are research boards managed by psychologists and other experts to which the local employers apply for help and in some others the employers themselves maintain separate psychological laboratories in their own establishments. I may mention in this connection the names of some of these organisations, carrying on personnel research studies in addition to other studies of psychological import.

England.—(*a*) The Industrial Health Research Board (formerly known as the Industrial Fatigue Research Board) established under the joint auspices of the Department of Scientific and Industrial Research and Medical Research Council; (*b*) The National Institute of Industrial Psychology organised in 1921 under the distinguished leadership of Dr C. S. Myers.

Germany.—Organisations like Greater Berlin Tramways, Siemens Company, Carl Zeiss and others. Similar institutes are to be found in almost all the larger cities in Germany.

U. S. A.—United States perhaps is the only country where thousands of organisations are engaged in personnel research activities.

Russia.—(*a*) The Central Institute of Labour at Moscow, established in 1920, under the leadership of Gastev. In 1931, the Central Institute alone was reported to have 1,000 branches throughout Russia; (*b*) The Institute of Labour at Charkow; (*c*) The Institute of Scientific Organisation of Work at Kasan.

Australia.—The Institute of Industrial Psychology, Sydney.

Japan.—(*a*) The Institute of Industrial Efficiency; (*b*) The Imperial University of Tokyo. Everywhere, for example in Holland, Belgium, Poland, Italy, Spain and so on such organisations are in existence, and listing the individual names of all those organisations will be simply a wastage of time. It is sufficient to say that scientific selection of personnel, and researches relating to that, are conducted all over the world, and let me add that in all these countries these problems are recognised as national problems.

The present war has further accelerated the importance of applying psychological principles in the recruitment of military personnel. In all countries, belligerent and non-belligerent, efficiency of personnel receives the highest consideration. In the three departments, the Army, the Navy, and the Airforce, the psychologists have been entrusted by the military leaders to deal scientifically with the problem of right selection, classification and training of military personnel. The psychologists administer suitable battery of selection tests to the recruits, and their recommendations as regards suitability of the latter, and the particular training department where the recruits should be assigned, receive ready approval of the authorities concerned. The peace-time establishments engaged in personnel research work are fully cooperating with the military authorities. But as the number of recruits who have to undergo testing is necessarily very high, considerable number of psychologists is needed, and there had therefore been a severe draining from civil to military lines of the psychologists who had been attached to universities and other establishments in the pre-war period. During the end of 1942 in U. S. A. alone, at least 25 per cent of the total pool, conservatively estimated nearly 4000, of professional psychologists had been serving in the Army, the Navy and the civilian agencies of Government.[1] Though unable at the moment to quote the actual figures of psychologists, military psychologists as they are called, engaged in war work in other countries of the world, it can safely be assumed that their number is considerable. In addition to some of the civilian personnel establishments which have been turned to military esta-

blishments due to war emergency, special military personnel research organisations have been set up to cope with the enormity of the size of the Army and also for studying the various special problems arising out of the war situations. Personnel research sections in war time specially came into being, because proper personnel selection was considered essential for efficient conduction of the war. They were not set up to carry on research for the sake of research only. Rather research is carried on as a service to the War Departments, and every problem that is studied is born of a real and urgent need. This vitalises the entire programme. Freedom and human lives, not theories, are at stake.[2] The activities of the leading foreign countries of the world in peace time and during war, regarding undertaking personnel research works amply bear testimony to the importance of such problem. Researches on personnel problems therefore can justly be labelled as national problems.

But what a poor contrast India presents as regards activities of such sort. It is really unfortunate that a human problem of such a serious import is completely overlooked by our countrymen. So much so that if anybody raises such a question he is looked upon with suspicion and very often than not is greeted with derision. The moment the question of practical applicability of the scientific principles of psychology to human needs is raised many people will be seen to back out, because they feel that the psychologists' claims are unreliable and impractical. If even at the face of psychologists' activities to the cause of national advancement, prevailing in the leading foreign countries, this orthodox attitude is still maintained it can not be anything but sheer transgression of the laws of human reasoning. Fortunately, India is taking lively interest in all scientific activities of the Western countries and is showing much earnestness for utilising them for her own advancement. The growth of various scientific researches signals the advent of a new India, not an orthodox India, but a scientific India. A bird's eye view of the recent scientific activities of India will be quite coherent in this connection.

The present scope of researches in different branches of science in India is utterly inadequate, as judged by her geographical immensity and vastness of her population. Scientific researches were held so long by the people to be of academic interest only. The idea that these researches can be made to serve national cause began to be apprehended only recently. It was felt that research works carried out in individual capacities, in university laboratories, or in a few industrial establishments would be quite inadequate to cope with India's demand. Different scientific and academic bodies, devoted to furtherance of the respective branches of science, therefore, began gradually to appear. Notwithstanding the establishment of these organisations, it was realised that so long the active support of the Government was not forthcoming, it would be nothing but puerile to expect proper utilisation of science to the cause of national advancement. As a result of united efforts some of those non-Government organisations, like the Indian Association for the Cultivation of Science, the Indian Institute of Science, the Bose Research Institute etc., received Government support in the form of endowments. The Imperial Council of Agricultural Research, the Indian Research Fund Association and other Central Institutes under the exclusive management of the Government of India, were also established gradually but I should say without any consistent plan. Then began the present war. The war has spurred the public mind and the Government as well. Inspite of having plenty of resources, India, for lack of sufficient organised bodies for scientific utilisation of those resources, is unable to meet the demands of the time. Mobilisation of the scientific and the industrial talents of the country for research and production of war materials, was realised to be immediately necessary and accordingly the Board of Scientific and Industrial Research, a central all-India scientific organisation, was set up by the Government in the month of April, 1940. The Board now receives an annual grant of ten lakhs of rupees from the Government.[3] The Indian scientists, the industrialists and the Government have been fully convinced that modern developments in science and technology, if utilised to their fullest extent, can give to every individual a fuller and satisfying life. Critical examination of the facilities for scientific research and training that are available in India, and drawing up of plans for improving and coordinating such facilities are going on at top speed. The scientists are trying to be more thorough and more exhaustive now than they had been before. One of the reasons for such a serious attitude on their part is their comprehension that after the cessation of hostilities India's status will depend considerably upon her scientific achievements. Demands of the time and post-war thoughts all coupled together have made the leaders of thought quite alert. The dictum that "Science is the soul of all progress and the source of all prosperity", has made a deep impression on their heart, and accordingly they are formulating various plans and policies by which Science can be harnessed to the needs of Industry and National Work in this country. Mr. Sargent, the Educational Adviser to the Government of India, has suggested a thoughtful scheme, by which education can spread and reach the huts of even the remote villages in India. The suggestion is a magnificent one and who will deny the importance of mass education to national cause. Again in addition to the endeavours

of private and other agencies the Government of India considering that industrialisation is another important tool of national progress, are it is learnt now engaged in ascertaining the position of various industries in the country, with a view to formulating plans for the future. A questionnaire drawn up by the Government after consultation with the Trade and Industry Reconstruction Policy Committee has been circulated to various industrial associations.[4] In a word it may be said that the whole country is now throbbing with policies and schemes for bringing about an all round national prosperity, and Indian scientists are to play prominent roles for success of those schemes. All these are good and undoubtedly quite encouraging and it is fervently hoped that no stone will be left unturned for utilising this opportune moment for advancing the national cause. It is fully obvious that we are to depend much upon the literature and other help of the foreign countries for these scientific activities, and the long standing experience of the latter are to be of immense help to us for making our efforts better organised. For a better organised scientific front none would dissent to the fact that proper coordination between the different branches of science is to be maintained, and a balanced distribution of importance should be given on each and everyone of them. Prof. Crowther in connection with planning of scientific development in Soviet Russia, observes, ". . . . balanced attention is given to all sides of science, that no important branch is neglected . . . ."[5] The different scientific organisations and boards and the framers of national schemes do not seem to take cognizance of this fact. The projects like industrialisation, mass education, agricultural research etc., as I have stated at the outset, definitely show the want of proportionate distribution of importance. Otherwise how can scientific psychology, be excluded from the scientific boards and national schemes? I think it is the attitude of the leaders of thought that is fundamentally responsible for the exclusion of such an important branch of science. They still hold the traditional belief that prosperity in the material aspect of a nation, will give every individual a fuller and satisfying life, and that is why exclusive importance is given to objective sciences. But the fundamental error in this policy is, to put it figuratively, just like fitting the material bolts in the human nuts, and making efforts to scrape with all attention the ridges of the former to make the fit right, without however attending to the quality of the ridges of the latter. A reorientation in policy is urgently needed to solve this situation and the activities of the foreign countries in this respect should be taken into account. Anyway it is high time now, to give a short picture of the status of psychology in India and to suggest how its scope can be expanded to the profit of all concerned.

It is to be confessed at the outset that in India, Psychology cannot claim a bright past as the other branches of objective science can in their respective spheres. Psychology as an independent subject-matter of study and research dates back to barely more than quarter of a century. It was only in 1916, at the initiation of late Sir Ashutosh Mookerjee, that the first Laboratory of Psychology in India was estabished under the auspices of the University of Calcutta. Since then other universities have been setting up laboratories. Notwithstanding the serious difficulties it had to face, this young science is growing rapidly and its field of applications expanding day to day. The psychologists of India have realised now that only university teaching and secluded laboratory researches cannot alone promote the cause of this science. As in other countries, the wider applications of scientific psychology in different spheres of everyday life, in education, in industry, sociology, specific diseases, vocational adjustment and of late in the realms of war, make them feel that they also can be helpful to the cause of their mother country provided they obtain proper facilities. They are very eager now to translate their theoretical knowledge into practical ends, in the different fields of national life, as their brother psychologists are doing with success in their respective countries. I may mention here that as a necessary foothold for furthering the cause of the science, psychologists like other scientists have built up an organisation of their own, under the name 'Indian Psychological Association' which was established in the year 1925. The Association runs a journal, *'The Indian Journal of Psychology'*, a quarterly publication and it is the official organ of the Association. The results of experiments and other researches of the psychologists are published mostly in this Journal. The Indian Science Congress Association having under its fold the different branches of Science came into existence in the year 1914, and psychology as an independent branch was incorporated into its body in the year 1924. I should name two other organisations which are responsible for spread of knowledge and application of a particular aspect of psychology in India. The Indian Psychoanalytical Society was established in the year 1922 under the distinguished presidency of Dr G. Bose with a view to promote the cause of psychoanalysis and for the general benefit of the people at large. A mental hospital with indoor beds and outdoor provisions has been set up only recently under the auspices of this society. Under the auspices of the Indian Mental Hygiene Association, the Carmichael Medical College, Calcutta, runs a psychological clinic where mentally diseased patients receive free psychological treatment.

Now when all countries in the whole world have recognised researches on personnel problems as

national problems, and are conducting those researches with beneficial returns, there cannot be any reason why India will remain behind as an exception and will not undertake similar tasks. The critic however may justly raise a vital question that under the prevailing conditions of meagreness of avenues of employment, and consequent state of acute unemployment in the country, what is the use of personnel research? Can such researches solve the unemployment problem? The aim of personnel research is not to create new avenues of employment or to solve problem of unemployment, but to help the employer in his task of selecting the right type of personnel and thus to utilise the human talents and temperaments in the best possible way. Of course it is true that the more the avenues of employment, the better would be the expansion of personnel research and it may be said that considerable increase of employment avenues is inevitable when in the near future industrialisation is expected to have its sway in India. It should be borne in mind therefore that provision for fostering special personnel researches should always be made whenever any new avenue of employment is opened. It will not be judicious to defer such researches to the future, the earlier we get prepared for it the better will it serve the cause of humanity.

The onerous task of initiation of such researches has already been undertaken by some bodies, academic and private as well. Commercial concerns like the Bombay Electric Supply and Tramways Company and the Calcutta Tramways are utilising psychological principles in the selection of their technical staff. A private institute in Bombay, under the name 'Batliboi's Vocational Guidance Institute', is reported to have in its programme, the aspect of personnel research. The only official organisation, engaged in personnel research problems is the Applied Section, Department of Psychology, University of Calcutta, established under the able leadership of Prof. G. Bose in the year 1938. Barring researches in individual capacities, we are not aware whether any other organisation has undertaken as yet similar works in their establishments. It is pleasing to note that the War Department, Government of India also has recognised its utility. They have set up recently an establishment under the designation, 'The Directorate of Selection of Personnel' at Meerut. The function of this directorate is primarily selection of military personnel with the help of psychological tests, and we believe, the method of work of the Directorate is the same as is followed in other countries in similar activities. Such a move on the part of the Government is surely encouraging. It is high time therefore that the Indian psychologists should put themselves together and formulate ways and means by which personnel researches can be conducted on a wide scale to the cause of national advancement. The following points if adopted after proper modification may facilitate such work.

1. That the existing laboratories of psychology in the universities be expanded and equipped so as to make it possible to carry on problems of personnel research and train students of psychology in that particular line.

2. That independent psychological laboratories be opened in those universities where they do not exist now and provisions be made by grants or endowments to open up special personnel research sections.

3. That the industrial and big establishments be approached so that they select their personnel on scientific basis and where possible maintain independent psychological laboratories in their organisations.

4. That the Indian Psychological Association which commands the voice of Indian psychologists be entrusted with the task of coordinating between different psychological organisations carrying on such works.

5. That a Central Board of Personnel Research be established, with well equipped psychological laboratory and well trained staff. Research results of different universities, Directorate of Selection of Personnel and other private or semi-private establishments, should be forwarded to this Board which ultimately will function as a coordinating centre. Every organisation in India should employ those personnel whom this Board after application of tests will recommend.

6. That the Board of Scientific and Industrial Research should add a separate wing to encourage research in personnel problems. This new section will be in charge of qualified psychologists whom the above Central Board recommends.

7. That all the recognised scientific boards and organisations, subsidised or unsubsidised by the Government, make wherever possible special provisions for encouraging the above psychological researches.

In conclusion it may be emphasised that in an atmosphere when all the different branches of science are busy in forwarding programmes and preparing plans for national regeneration it is to be regretted that the human aspect is not in the focus of attention of our leaders of thought. A reorientation in policy is urgently needed to do away with this traditional disregard towards solving human problems, directly and not indirectly as is the common practice. We ought to

be careful that no important scientific branch is neglected in the formulation of all nation-building programmes either for immediate effect or for the post-war period. The traditional disregard can be amended if we adopt the following policy. The human materials are to be analysed, the psychological factors that count upon their happiness are to be assayed, so that a psychological profile may be obtained. Policies may then be so framed and physical materials so handled that they may best fit the profile obtained psychologically. Research in raw materials and human materials should run commensurately side by side, and this alone can bring about an all round national prosperity on a firm and long-standing basis.

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MAHARAJA SAWAI JAI SINGH II, (1686-1743)

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[The ruling family of the State of Jaipur belongs to the Rajput clan known as the "Kachchwa", and in popular belief the clan is supposed to be descended from Kusa, the son of Ram of the solar family of Ayodhya and hero of the great epic Ramayan. Historically, the family can be traced to the 11th century A.D., when Arjun of the Kachchapaghata family held the fort of Gwalior as a feudatory of the Chandelah kings of Mahobah and Kalinjar. Gwalior continued to be the seat of the family who later claimed sovereign dignity, but later a junior member of the family migrated, and inherited Amber from his father-in-law. In the sixteenth century, the then Maharaja of Amber entered the service of Akbar the Great, and his grandson Maharaja Mansingh rose to be the greatest general and a notable figure of the court of that great monarch. The Jai Singh of this article is to be specially distinguished from his name-sake and great-grand-father, Mirza Rajah Jai Singh who, as the ablest general of Emperor Aurungzeb, reduced Sivaji to submission. Not many Indians of the great ruling families have distinguished themselves in the field of letters and science. The only parallel to Jai Singh is Rajah Bhoja of the Parmar family (1010-1062 A.D.), sovereign ruler of Malwa. Jai Singh's astronomical taste was acquired by his sons and successors, Maharajas Iswari Singh and Madho Singh, who continued their father's labour of love so that Tod's assertion that his wives, concubines and science perished with him in his funeral pyre errs too much on the rhetorical side. Maharaja Madho Singh is credited with the discoveries of new instruments.

Ed.—Science and Culture.]

THE bicentenary* of the death of Maharaja Sawai Jai Singh II, ruler of the State of Amber and founder of the city of Jaipur, deserves more than a passing notice, so varied were his activities and so remarkable his gifts. It would be well to glance at the political and intellectual setting in which Jai Singh was placed, if his worth is to be truly appreciated. Maharaja Jai Singh succeeded to the sovereignty of Jaipur, then known as Amber in 1699, at the age of thirteen. Eight years later, in 1707, Aurangzeb, the last of the great Moghuls passed away, and was succeeded by the line of the lesser Moghuls, from whose infirm grasp power was gradually to slip away. The house that Babar built was showing signs of decay ; though the convulsion that cracked its very foundations came in 1739 when Delhi was sacked by Nadir Shah. This was in the fortieth year of Jai Singh's reign and four years before his death. The old empire was passing away, and new and powerful forces were gathering strength in the north, the east and the south. During these troublesome times Jai Singh stood loyally by the throne of Delhi, and his reputation in the court always stood high. He was called upon to become, first, the governor of the province of Agra, and was later transferred to the governorship of Malwa. He was wise to take notice of the rising power of the Mahrathas, and as a result of his persuasion Malwa was finally ceded by the Emperor Muhammad Shah to the Peshwa to be held perpetually in nominal fief to the throne of Delhi. It was due to his intercession that the sore of the 'Jeziya' tax (Poll-tax on non-Muslims) was finally removed. Jai Singh took the opportunity to establish the power of his house on a firm and solid basis amongst the Rajput States, and considerably extended the frontiers of his territories. The times were hazardous and uncertain in the extreme, and were such as to have put the resourcefulness of the ablest to the test. Jai Singh steered his ship clear of all lurking dangers with consummate skill and ability. He felt the situation of his capital at

* Written on the occasion of the bicentary of the death of Maharaja Sawai Jai Singh II, ruler of the State of Jaipur in Rajputana.

Amber too insecure against invaders, and he decided in 1728 to shift about seven miles southward to a new city he founded, and this he named Jaipur. This is unique amongst Indian cities in plan and layout, and still stands a monument to its founder's passion for precision and regularity; for its principal thoroughfares (width 110 ft.) run east and west and the main cross-roads run north and south. The Temple of the Sun stands a white robed sentinel over it at the eastern extremity on a hill on the outskirts of the city.*

Maharaja Jai Singh found time to indulge to his heart's content in intellectual pursuits uncontaminated by acts of questionable value attaching to many of the political and military activities which crowded upon him in a way he could not help. The precision and elegance of the methods of astronomy and the mystic lore of astrology had early cast a spell upon him. By intense study and application he made himself conversant with the traditional Hindu system of astronomy, the principal source of which was the '*Surya Siddhanta*'.† The origin and date of this work are not easily traceable. But, Jai Singh undoubtedly missed in it the precise observational data for which he longed. The dominant influence of the Grecco-Babylonian school of astronomy had been felt in the East since the time of the Seleucids (313 B.C.—65 A.D.) and continued to be a living force when Europe, on the break up of the Roman Empire lapsed into barbarism during the times known as the Dark Ages. But during these times, the Moslems became the custodians of the culture of the Babylonians and the Greeks. The basis of the astronomical lore amongst the Moslems was Ptolemy's great work, '*Syntaxis*', which in Arabic translation is known as '*Al Majista*'. It reappears later in Europe under the name '*The Almagest*'. But the Moslem Savants made constant addition to this store of knowledge, from their own observations and studies. Jai Singh studied it carefully from Muslim sources, and it is known to him as 'Mijasti'. He appears also to have studied with diligence the elements of Euclid from the translation of Nasir ul Din al Tusi* who lived about the middle of the 13th century. Jai Singh was much impressed and attracted by the work of the Muslim astronomers, whose anxiety to carry out precision measurements found a ready echo in his heart. The work of Mirza Ulugh Beg (1393—1449 A.D.) and his assistant, Jamshid el Kashi, is especially noteworthy. A grandson of Timur the Lame, Ulugh Beg was a ruler and an astronomer even as Jai Singh was in later times. Mirza Ulugh Beg devoted himself with great zeal to astronomical studies all his life till it was ultimately cut short by the dagger of the assassin. Ulugh Beg had erected an observatory at Samarkand about 1425 A.D., and from his numerous observations had compiled a set of useful astronomical tables which superseded those of Ptolemy. The tables of Ulugh Beg were adopted by Jai Singh as basis for his future work. The Arabs and other Muslim astronomers were adepts in the construction and use of the astrolable ; but here Jai Singh differed from them, and was always suspicious of brass instruments which, he argued, could never yield results of any high accuracy because of their mecha-

MAHARAJA SAWAI JAI SINGH OF JAIPUR.

* The chief engineer in the construction of the city was Vidyadhar Bhattacharyya, a Brahmin of Bengali extraction, and descendant of one of the Brahmins who was brought by Jai Singh's ancestor Maharaja Man Singh from Bengal. Ed.—*Sc. & Cul.*

† According to Prof. P. C. Sen Gupta, the 'Surya Siddhanta' had its beginning probably in the fourth century A.D., but was constantly revised, and in its present form, probably dates from the 11th century, when all final revision of astronomical elements completely ceased.—Ed., *Sc. & Cul.*

* Nasir ul Din al Tusi was a Persian astronomer in the service of Hulaqu Khan, conqueror of the Khalifate. In 1259, Hulaqu built for Nasir ul Din an observatory at Marāga, where the astronomer observed for a long time. These observations were published under the title of 'Ilkhanic Tables'.—Ed., *Sc. & Cul.*

nical imperfections. He early decided to erect firm and stable masonry instruments, giving them such generous dimensions that with their aid, accuracy in observations which was still then unrivalled could be achieved.

While Jai Singh was busy in these projects, a revolution had already taken place in European Astronomy through the labours of Copernicus (1470-1542), Tycho Brahe (1546-1601), Kepler (1571-1630), Galileo (1570-1642) and Newton (1642-1727). Newton's '*Principia*' was published in 1686, the year of Jai Singh's birth; and the incomparable genius of Newton had laid bare most of the mysteries of planetary motion, and had traced them to the law of universal gravitation. A faint echo of these happenings in Europe must have reached the ears of Jai Singh, principally carried to him by the Jesuit missionaries, who had appeared in numbers in India about this time.* Jai Singh's thirst for knowledge was insatiable, and any source was welcome to him which could allay it. For this purpose, he sent emissaries to distant lands, Muslims like Muhammad Sharif and Muhammad Mahdi to the Muslim centres of learning; and "several skilful persons along with Padre Manuel", as the Maharaja himself puts it, to Europe. He invited scholars to Jaipur for consultation. Perhaps, the most picturesque of these was Jouvier de Sylva, the Portuguese, who made Jaipur his home. Besides being an astronomer, he was a physician of repute, and known locally as Hakim Martin. His home and his descendants are seen to this day in Jaipur, and one of the roads of the city bears his name. From these sources Jai Singh became acquainted with the principles and use of the logarithms and trigonometrical ratios, and also with the astronomical tables of Flamsteed, the first Astronomer Royal of Great Britain (*Historia Coelestis Brittanica*) and la Hire's *Tabula Astronomica*. Jai Singh does not appear to have realized the full significance of the revolution in astronomical knowledge brought about between 1473 and 1687. He valued astronomy, like most of his European contemporaries, on account of its use in astrology (*i.e.*, the pseudo-science of predicting the future from positions of planets, sun and the moon), and does not appear to have realized that after the successful explanation of planetary motion by Newton, astrology had lost all pretensions to a scientific basis.

About 1724, Jai Singh constructed his first observatory at Delhi with masonry instruments, which, as we have seen, he preferred to brass ones. He spent seven years of careful observation, which he decided to embody in proper tables. His principal collaborator in this as well as all subsequent work was Pandit Jagannath (a Brahmin of Telegu extraction) who was equally at home in Sanskrit, Arabic and Persian, learned in Hindu as well as Muslim astronomical lore. With the aid of Jagannath, he got the Arabic version of Ptolemy's '*Almagest*' translated into Sanskrit under the name '*Samrat Siddhanta*' (*lit.* the emperor amongst astronomical treatises) and Euclid's elements under the name '*Rekhaganita*'. Ripe with experience gathered at Delhi, Maharaja Jai Singh constructed an observatory on an even more ambitious scale at his newly founded capital, Jaipur, about the year 1734. As he says,

> "To confirm the truth of these observations, he (meaning himself) constructed instruments of the same kind in Sawai Jaipur, Muttra and Benares and Ujjain. When he compared these observatories, after allowing for the difference of longitude between the places where they stood, the observations agreed."

Jai Singh's Tables give the numbers of constellations and stars with their longitudes, latitudes, right ascensions, declinations, and magnitudes. It thus closely follows the lines of the catalogue of Ulugh Beg.

Jai Singh commences the work in the orthodox Hindu style. He renders praise to the Almighty "in the comprehension of Whose Wisdom Abarkhas (Hipparchus, Greek astronomer *cr* 130 B.C.) is an ignorant clown, in the presence of Whose Radiance Vitlamayus (Ptolemy, Alexandrian astronomer *ca* 150 A.D.) beats his wings as helpless as a bat in sunlight, and to understand whose ways Euclid and Jamshid Kashi and Nasir Tusi have been striving in vain."

Jai Singh appears to have been quite satisfied with the results of his labour. He says,

> "Since in this place by the aid of the unerring Artificer, astronimical instruments have been constructed with all the exactness that the heart can desire and the motions of the stars have for a long period been constantly observed with them, agreeable to observations mean motions and equations were established; he found the calculation to agree perfectly with the observations."

This important work Jai Singh dedicated to Emperor Muhammad Shah, "the incomparably brightest star of the heaven of empire, an Alexander in dignity, the shadow of God, the victorious king Muhammad Shah: May he ever be triumphant in battle."*

Jai Singh's Astronomical Instruments

We shall here describe some of the instruments in these observatories especially those at Jaipur and

* It is not probable that Jai Singh was familiar with the works of Copernicus, Kepler, Galileo and Newton, for these works were under papal interdiction, and Jesuits who were Jai Singh's principal informants were forbidden either to study or teach them.—Ed. *Sc. & Cul.*

* These high-sounding epithets appear too flattering when applied to a worthless king of the type of Muhammad Shah (1719-1746), but we must remember that Jai Singh was writing before 1739, thet date of Nadir Shah's sack of Delhi. —Ed. *Sc. & Cul.*

Delhi. The one immediately to arrest the attention of the visitor is the *Samrat Yantra* or the Equinoctial Sun Dial.

Samrat Yantra (*Equinoctial Sun Dial*).—It consists of a wall in the shape of a right angled triangle, ABC (Fig. 1a), the hypotenuse AB of which is the gnomon pointing towards the north pole. The plane of the triangle is in the meridian and the angle ABC is equal to the latitude of the place. In the Jaipur instrument, the vertical side AC is about 90′ in height, and the hypotenuse is thus something like 147′ long corresponding to the latitude of 27°. With centre O, a point on the hypotenuse, and radius OR, an arc of a circle is drawn in a plane at right angles to that of ABC. If PRQ (Fig. 1b) is the arc of the circle with centre O, and R is the point of intersection of the gnomon ABC and the quadrants PRQ, the shadow of the gnomon will fall on R at noon. The quadrants PRQ will be parallel to the plane of the equator. If the shadow of the gnomon is at S on the quadrant at any time, then, the angle SOR gives the local time ante or post meridian as the case may be. At Jaipur, the radius OR is about 50′, and the arc PRQ is in the shape of a cylindrical strip, about 9′ wide. If a pointer X be held on AB such that its shadow falls on the quadrant at S, then XRO will be the declination of the sun at the time. Its tangent is equal to XO/RO, and as RO is of fixed length XO will be a measure of the declination. AB carries graduations which thus enable us to find the declination of the sun at any time. Though the equinoctial sun dials were fairly common before Jai Singh's time, the use of the gnomon to find the declination of the sun is an invention peculiar to his observatories.

Along CB on the ground runs a channel, which, when filled with water provides the horizontal level. The Jaipur instrument is graduated to read to a second of arc, but the lack of sharpness of the shadow of the gnomon sets a practical limit of accuracy somewhat less than this. The original construction was of masonry and the graduations were in plaster. The instruments were reconstructed in 1901 under the supervision of Lt. A. H. Garraet, R.E. Recently, the plaster has been replaced by marble stone both on the quadrants and the gnomon. Opportunity has also been taken to remove slight discrepancies in the original graduations and angles during this work carried out under the supervision of Pandit Kedar Nath, the Officer-in-Charge of the Observatory. The dimensions of the Delhi sun-dial are smaller than those of the Jaipur instrument.

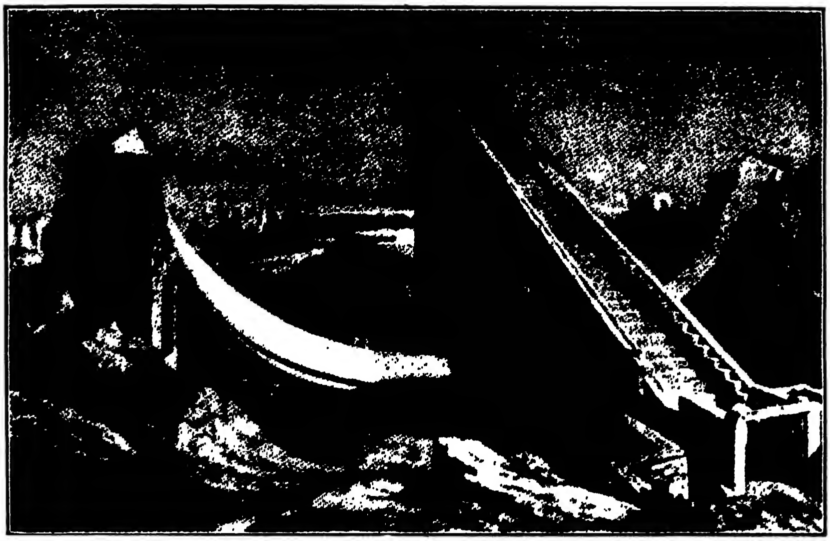

Fig. 1. Samrat Yantra, Delhi.

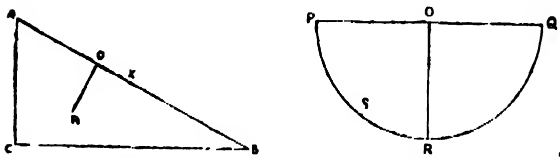

FIG. 1a. FIG. 1b.
Samrat Yantra.

Shasthamsa Yantra (*Sextant or Aperture Dial of Nasir-ul-Din*).—Adjoining the *Samrat Yantra* is the

Shashtamsa Yantra. This is a long narrow room in which are constructed two arcs on the opposite walls parallel to the meridian, each of radius about 28'. There is a hole in the roof for each arc through which sunlight enters at noon and falls upon the arc. This gives the time of noon and also the sun's declination at noon. It produces a weird effect, indeed, upon one standing in this narrow and lofty room at noon, to observe the spot of sunlight as it glides silently down one wall, crosses the arc, and creeps up the opposite wall.

The Nari Valaya Yantra (Circular Dial).—Another type of a sun-dial is the *Nari Valaya Yantra.* It consists of a cylinder of about 10 feet diameter

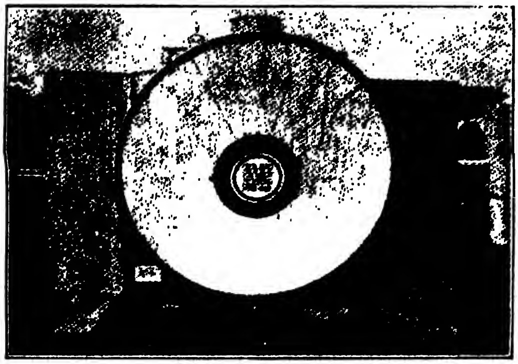

Fig. 2. Nari Valaya, Jaipur Observatory.

with its axis parallel to the earth's axis and the meridian. The faces of the cylinder are parallel to the equator, on which are placed two metal styles. At equinox sunlight falls on both the faces, but before and after the equinox only one of the faces is illuminated at a time. Each face carries hour angles, and the shadow of the style denotes the hour of the day.

The Jai Prakash (the Bowl of Berossus)* –Perhaps, the most versatile of Maharaja Jai Singh's instruments is the *Jai Prakash.* It is a concave hemispherical bowl made of stone and sunk into the earth. The diameter is about 18 at Jaipur and about 27' in the Delhi instrument. The circular rim NS represents the horizon. The markings inside are the images on the sphere of the points in the heavens through the centre O of the hemisphere. The figure represents a cross section in the plane of the meridian. Z represents the zenith and P the North Pole. Surrounding Z are circles such as AB and NS, showing the altitudes or the zenith distances. Great circles through Z indicate the azimuth. Similarly, surrounding P are circles such as RM which are the diurnal or latitude circles. These include the equator OQ, and the tropics. The angle SOP is equal to the latitude of the place. Two wires are stretched over the rim in the north and south direction, NS, and in the east and west direction. They, thus, intersect at the centre O. If the shadow of this point of intersection falls on the surface at C, QC is the declination of the sun and ZC its zenith distance. Similarly, the other co-ordinates are found. There are also circles on the hemisphere belonging to the signs of the zodiac such that when the shadow of the centre is on any one of them the corresponding sign is crossing the meridian. If observations are to be taken for a heavenly body other than the sun, it has to be done at the surface of the hemi-

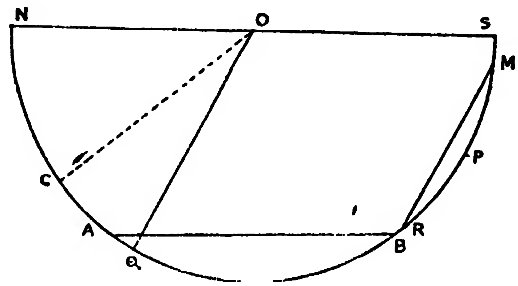

Fig. 3. Jai Prakash.

sphere, to reach which open channels are left in the surface. As much of the surface is thus lost, a complementary hemisphere is constructed in which the rulings cover the surface corresponding to that missing in the first. There is another similar instrument, the *Kapala,* differing from the *Jai Prakash* only in that the rim does not represent the horizon but the circle passing through the pole and the solstitial points. This will indicate a sign rising on the horizon when the shadow of the centre is passing its circle. This is of prime importance to the astrologer ; for, the cardinal datum for casting a horoscope is the point of the ecliptic rising on the horizon at a given time.

Kaye makes the following observations in the *Astronomical Observatories of Jai Singh,* published by the Archaeological Survey of India, 1918.

"The *Jai Prakas* is practically the hemisphere of Berossus, somewhat elaborated, and the *Samrat Yantra* may also be considered as evolved from that instrument.* This only means, however, that the dial of Berosus was of a very general nature. It consisted of a hemispherical bowl, placed with its rim horizontal, and in the centre and in the same plane as the horizontal edge, was fixed a bead, whose

* Berossus was an astronomer of Babylonian origin who opened a school of astronomy in the island of Cos, about 280 B.C., and taught the Greeks elements of Babylonian astronomy and astrology.—Ed. *Sc. & Cul.*

shadow on the concave surface of the hemisphere marked the trace of the sun's diurnal path. The resemblance to the *Jai Prakas* is striking enough, but it is doubtful whether Jai Singh had any knowledge of the earlier instrument; he could only have learnt of it from he Muslim astronomers (*e.g.*, al Battani, who refers to the principle of the instrument). The *Jai Prakas*, however, is something more than the bowl of Berossus, for it is fully graduated and appears to have been based upon the Muslim instrument known as *al-Masatirah*, descriptions of which are found in the works of the Muslim astronomers."

The Rasi Valaya Yantra (*Zodiac Dials*).—Based on the same principle as the *Samrat Yantra* is a group of twelve dials known as the *Rasi Valaya Yantra*, or the Ecliptic instrument. The quadrant

Fig. 4. Rasi Valaya (Capricornus).

of each of these lies in the plane of the ecliptic when the corresponding sign is rising on the horizon, and the gnomon points towards the pole of the ecliptic at the instant. These instruments are smaller than the *Samrat Yantra*, the radii of the quadrants not exceeding 5½ feet in diameter.

The Digamsa Yantra (*The Azimuth Instrument*).—The Azimuth Instrument,—the *Digamsa Yantra*, consists of two coaxial cylinders in the form of walls of 27 feet and about 18 feet diameter with a central

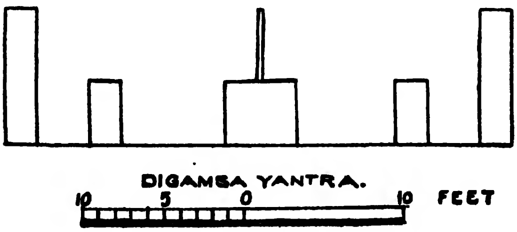

Fig. 5. Digamsa Yantra.

pillar about 3 feet high for the axis. The inner wall is about 3 feet high and the outer one about 6½ feet at Jaipur. The walls are graduated, and by the aid of a string tied to the axis the azimuth of any heavenly body can be found, holes being left in the walls for the purposes.

The Ram Yantra (*Azimuth Observation*).—There is a similar instrument, the *Ram Yantra*, consisting of a cylinder and axis in the form of a wall and

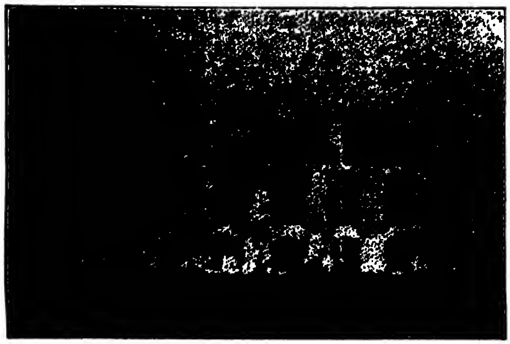

Fig. 6. Ram Yantra, Delhi.

pillar. The inside of the wall carries graduations for azimuth and altitude determinations. The diameter of the Jaipur instrument is 23′ and height 11′ 4″, while the axis is a pole of about 2″ diameter. The Delhi instrument is much bigger with a diameter of 55 feet.

The *Dakshinovritti Yantra* (*Meridian Circle*).—The *Dakshinovritti Yantra* is the transit circle consisting of two graduated acres on an open wall in the plane of the meridian. There are pins on either arc to give the altitude of heavenly bodies passing the meridian. The radii of the arcs are about 20 feet.

At Delhi is found the curiously novel *Misra Yantra*, or the Mixed Instrument, consisting of a set of arcs inclined to the meridian plane of Delhi by

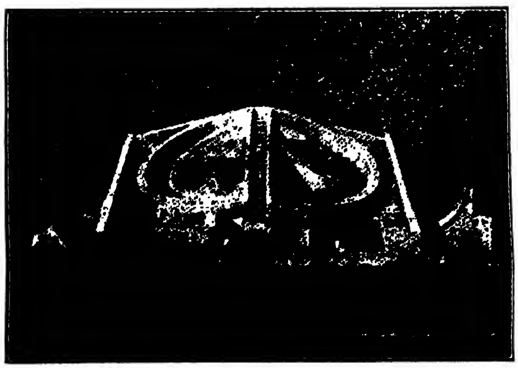

Fig. 7. Misra Yantra, Delhi.

* This is rather doubtful.—Ed. *Sc. & Cul.*

amounts 77°16′ W, 68°34′ W, 68°1′ E and 75°54′E. Two of these may be taken to correspond to the meridians of Greenwich and Zürich.

There are also a few metal instruments to be found at Jaipur and elsewhere. The principal of these are two astrolabes at Jaipur about 7 feet in diameter and more or less of the conventional design. The one made of a number of iron sheets has all its graduations effaced. The other one is made of brass, and its disc carries stereographical projections of the horizon and 'almucantarats', azimuth and hour circles for 27° latitude, and the equator and tropics. The *Chakra Yantra* is an equatorial, 6 feet in diameter, rotating about an axis parallel to that of the earth. Graduated circles give the hour angles and a pointer with tube is employed for sighting. The *Kranti Vritti Yantra* consists of two brass circles, one capable of rotation in the plane of the equator and the other in that of the ecliptic, thus giving celestial latitude and longitude. It is no wonder that these weird looking collections of instruments have won for Maharaja Jai Singh's observatories the name of Jantar Mantar.

Such, in brief, is an account of the intellectual achievements of this remarkable man. The crowded career of Maharaja Sawai Jai Singh* came to an end in 1743. His observatories stand today as he erected them, monuments to his greatness and breadth of vision. Astronomy, especially in the West, has moved fast and far from the time of Tycho at Uraniborg to the present days of the giants of Mt. Wilson and Palomar, and it is easy to imagine how lively would have been the reactions of such activities upon a mind so profound as Maharaja Jai Singh's if he could have witnessed them.

* J. Tod seems to be the earliest of the English chroniclers of Maharaja Sawai Jai Singh, whose career he has described in the *'Annals and Antiquities of Rajasthan'* (1832). Before him, W. Hunter had published in 1799 his paper in the *'Asiatic Researches or Transactions of the Society Instituted in Bengal'* on 'Some Account of the Astronomical Labours of Jayasinha, Rajah of Ambhere or Jayanagar'. The fullest and most comprehensive account of his astronomical work is contained in the excellent Monograph of G. R. Kaye, *'The Astronomical Observatories of Jai Singh'* and its smaller companion volume on *'The Observatories at Delhi, Jaipur, Ujjain and Benares'*, published by the Archaeological Survey of India.

TRAINING OF THE TENNESSEE RIVER

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The River

THE Tennessee River begins its career from Knoxville where it is formed by the junction of two rivers, the French Broad and Holston, from the Appalachian highlands. The Tennessee after traversing a meandering course of 650 miles joins the Ohio River at Paducah. The upper half of the river is fed by a number of affluents: the Clinch, Powell, Little Tennessee, Hiwassee and a number of smaller torrents. This part of the upper catchment area lies between the Cumberland Range on the north and the Appalachian mountains on the south.

The river before it was taken over by the Tennessee Valley Authority was extremely erratic in its behaviour. The Appalachian catchment is frequently drenched with the torrential downpours from the monsoon squalls rising from the Gulf of Mexico and the waters used to run in abrupt surges of flood without any warning. The flood in the Tennessee river not only used to inundate its own banks, but its discharges were large enough to endanger the Lower Mississippi basin. A short time after the flood, the river dropped quickly to a streak of feeble stream with depths of 2-3 ft. In dry season, the flow was so small that it was useless for navigation. At places the river fell as low as one foot. Jacks and Whyte[1] remark:

> "The Tennessee River has the characteristics of a river draining a badly eroded region. It receives a continuous accession of silt which fills up an artificial channel as soon as it is dug, and the flow is marked by extreme irregularity." (p. 235).

The Basin

The Tennessee basin has an area of 40,600 sq. miles with a population of about 6 millions. About 2 millions of the total population are engaged in agriculture, animal husbandry and dairy farming, while about 4 millions have found their occupation in the

industries which have greatly developed since 1933 under the river organisation TVA.

The lower valley of the Tennessee is fertile and suitable for cultivation. The upper reaches contain valuable mineral resources such as iron, coal, chromite, copper, magnesium, ferromanganese, rock prosphate, etc., and also contain valuable building materials like building stones, sand, high silicon pebbles, kaolin, bentonite, vermiculite, etc.

This part of the valley was formerly covered with jungle, but as the human settlement grew the jungle was cleared to make way for agriculture. The country became bare and badly denuded. The floods and soil erosion then began to engage the attention of the settlers, and in some places embankments were built to protect cities and agricultural land.

the whole work, each State saw a possible encroachment on its rights. The vested interests, such as the local electric companies, apprehended a menace to their trade if cheap electricity were developed from the projected hydro-electric stations. Jacks and Whyte observe "Several abortive schemes for social and land improvement failed in the past because the sanctity of State rights precluded putting a comprehensive regional scheme into operation. Under the Constitution of the United States irrigation and water-power systems and land-use plans (which enter largely into the TVA's programme) are matters for State legislation. The Constitution offered an insuperable legal barrier to any scheme which necessitated encroaching on State rights over land and water and faced with the alternative of abrogating sovereign rights or per-

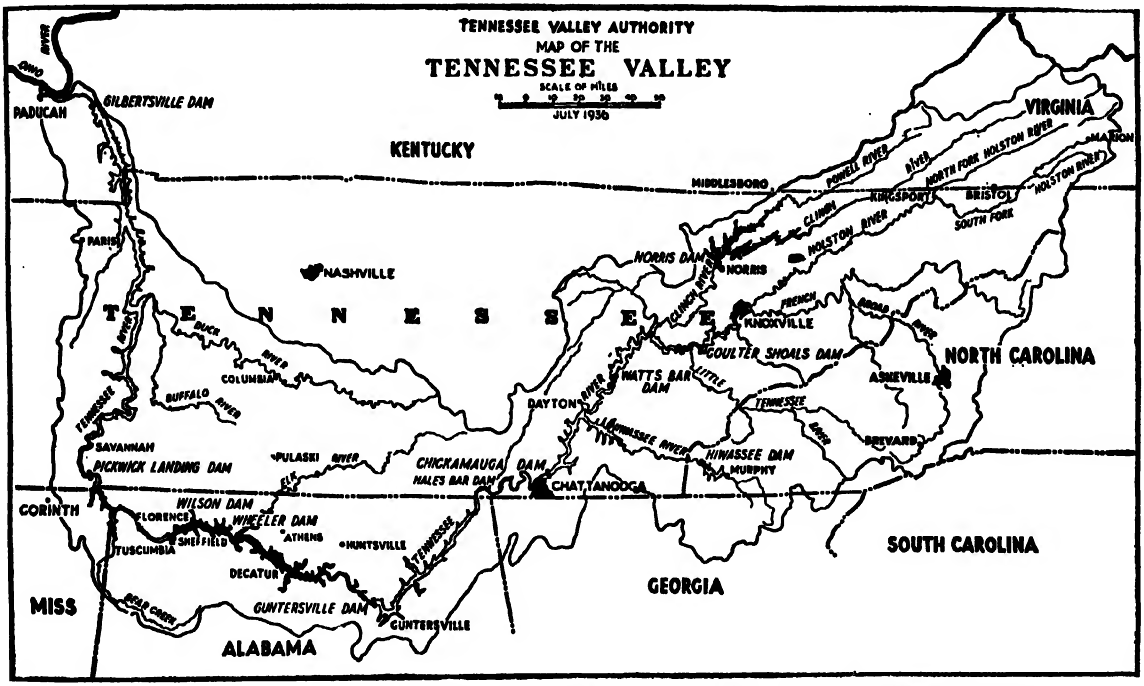

FIG. 1. Map of the Tennessee Valley. *(Reproduced from 'Wonders of World Engineering', Vol. 3).*

THE PROBLEM OF THE BASIN

It was felt that a radical solution on scientific basis to the twin problems of flood and soil erosion was possible, and though attempts were made from the beginning of the century, they were unsuccessful due to the conflicting views of the seven States through which the river passes, and for other vested interests which had grown up in the valley. The States could never agree and when proposals were made that the Federal Government should take over

mitting a disaster to be perpetuated on a fraction of their total territories, the States, represented mainly by public-utility interests, naturally chose the latter, as any other States in America or elsewhere would have done."

After 1927, the great economic depression came and in order to relieve the crisis, President Roosevelt began his New Deal campaign in 1933. Vast constructional works, which included improvement of river-basins on a scientific and totalitarian basis, formed the main feature of the New Deal. Let us see

how Roosevelt broke through the citadel of State and vested interests. Jacks and Whyte write:—

"In order to avert an irreparable disaster to a region equal in area to England and Wales, a way round the Constitution had to be found, and to secure a charter for its work of economic reconstruction the TVA had to express its objects somewhat indirectly. In contrast with land reclamation on State territory, river and flood-control, the benefits from which are not limited by State boundaries, are matters in which the Federal authority can intervene. The TVA was therefore able to obtain a charter to develop the Tennessee River for navigation, but not to stop the erosion which was eating into the vitals of the whole Tennessee Valley. The principal function of the TVA is to maintain a permanent navigable channel nine feet deep in the Tennessee River under all conditions of flow."

Under directions from the President, the Congress created the Tennessee Valley Authority instructing it "To improve the navigability and to provide for the flood control of the Tennessee River, to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for the agricultural and industrial development of the said valley . . . . .". This Act became effective on May 18, 1933.

Water Resources of the Tennessee Valley

Let us now explain in simple language how the planning has been done.

The heads of the uppermost tributaries of the Tennessee River lie at an elevation of about 3000 feet above sea-level and come down to 810 feet at Knoxville after a course of some 150 miles. From the profile of the Tennessee River (Fig. 2) it will be found that the slope is more or less regular from Knoxville to Decatur which has an elevation of 530 feet, representing an average gradient of 0·8 ft. or 9½ inch per mile for 340 miles. Between Decatur and Florence, there is a 'rapid' or steep slope which has a maximum gradient of about 5 feet per mile. Beyond this the river flows through a very flat part of the country with an average slope of some 4 inches to a mile for about 200 miles. The total fall between Knoxville and Paducah is about 500 ft.

The rainfall on the different parts of the Tennessee Valley varies from 40 to 80 inches with an annual average of 51·2 inches. This amounts to an annual precipitation of about 110 million acre-ft.* of water over the entire 40,600 sq. miles of the area. The upper catchment receives more of the rain which feeds the large number of important tributaries. These rivers flow between the well-defined ridges of mountains making excellent dam sites. The whole of this water does not reach the river, but only a fraction of it. The average run-off, *i.e.*, the actual flow into the stream, for a river of this type, may be taken to be about 60 per cent of the rainfall for the upper valley, and between 20 to 40 per cent for the flat lower valley. The average run-off for the entire basin may be taken to be 40 per cent, so that we may take that the amount of water reaching the river is 44 million acre-ft. The average head through which this mass of water falls may be taken to be 330 ft. The amount of work which the river performs during this drop can now be easily worked out. It is well known that 1 acre-ft. of water falling through a height of one foot gives us one unit (kilowatt hour) of energy.

So 44 million acre feet of water falling through 300 ft. does work equal to 44 million × 300 = 13,200 million kwH. This is a huge amount of energy, and is nearly 50 per cent of the total electrical energy produced in the whole of the U. K. in the year 1938; there it was obtained by burning nearly 10 million tons of coal. To this must be added the work done by the tributaries which, though they have less water have greater head.

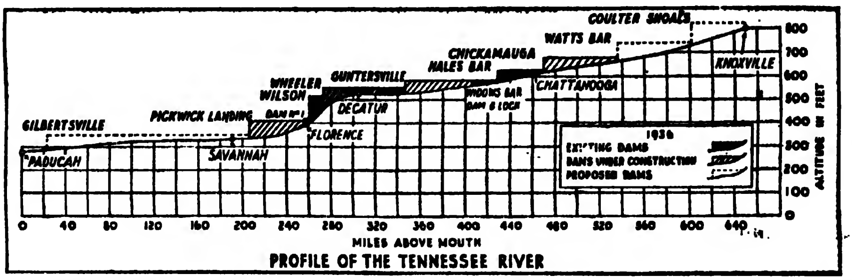

Fig. 2. Profile of the Tennessee River. *(Reproduced from 'Wonders of World Engineering', Vol. 3).*

It is clear that the whole of the work done by the river cannot be harnessed but with proper planning, and provided that suitable sites are available, a large percentage of the potential energy of the river can

* 23 acre-ft. = 1 million cu. ft.

be turned to electrical energy. There is a widespread belief that running water cannot be profitably harnessed unless it could be made to drop through a large head exceeding some 150 ft. as in a waterfall. But then new types of turbines have been invented and great engineering progress has been made, which

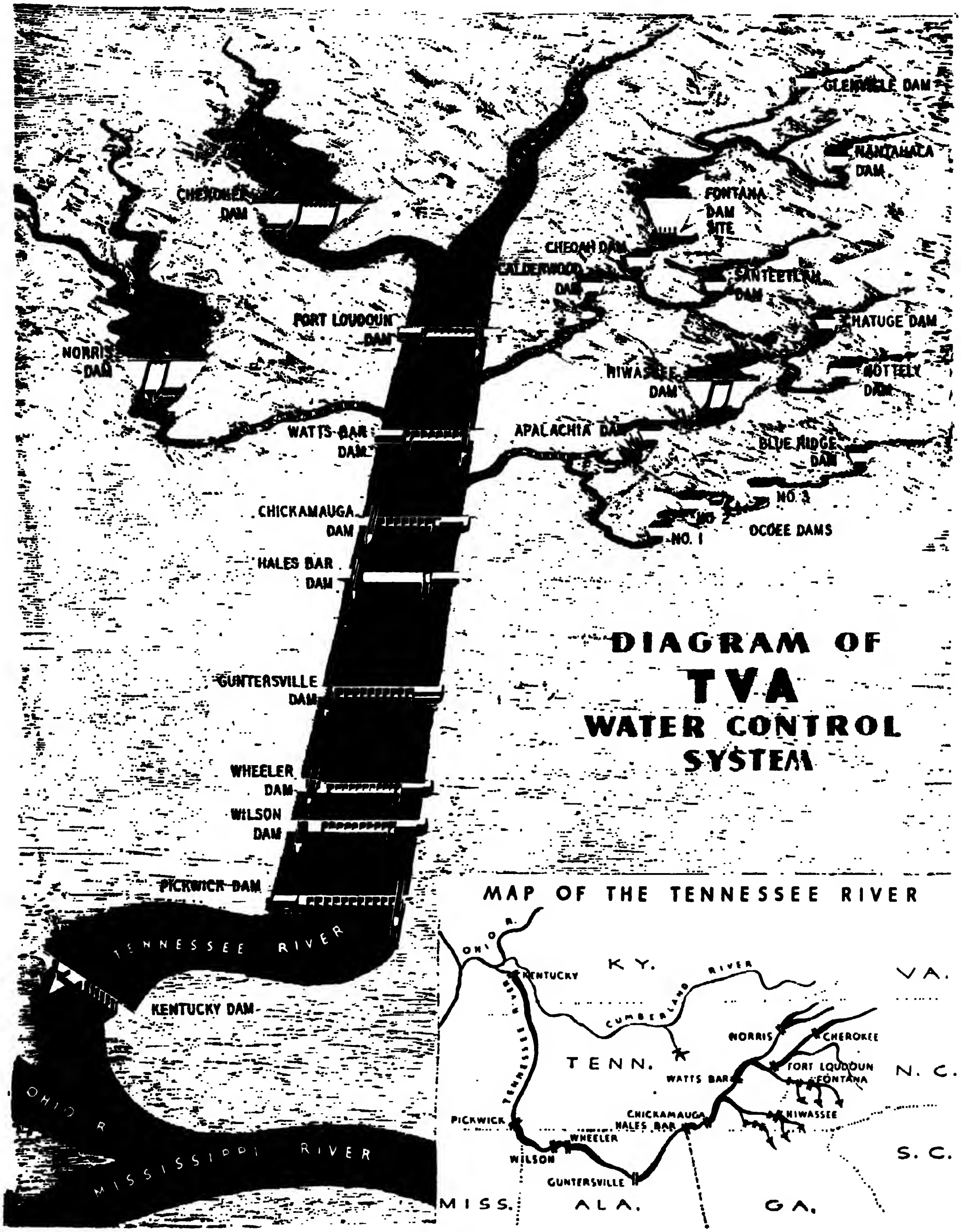

FIG. 3. TVA Water Control System. (*Reproduced from TVA Annual Report, 1941*).

have rendered it possible to develop efficient hydro-electric generators from as low a head as 30 ft.* Table 1 shows[2,3] to what extent the TVA engineers succeeded in their scheme. The core of the work is as Jacks and Whyte observe *"The creation of a series of dams in order to control the flow of water at all seasons."*

We also quote from the Reports of the TVA—

"Eight years ago Congress assigned to TVA the task of developing the Tennessee River and its watershed. In the river channel, on the land, and in the laboratory, the assignment has already led to lasting achievements. Dams, locks and power houses, built by the Authority and operated as a unit, have arrested the flood waters in their destructive rush to the low land. Released according to schedules that take account of the Valley region's year-round needs for power and flood protection, the waters of the Tennessee are now stepped down through a series of slack-water lakes that form a navigable channel to the Mississippi and thence to the oceanway of the world.

On the watershed the Authority is enabling the people to reclaim and revitalize many thousands of acres of their forest and agricultural lands. In the laboratory intensive research is uncovering new opportunities for taking advantage of native resources in the everyday business of earning a living. Working with the people and through their institutions, the TVA is perfecting new cooperative techniques for solving region-wide problems that overrun established political boundary lines."

TABLE I

DETAILS OF THE DAMS

Dam (* *indicates those completed by early 1943*)	River	Height of Dam (ft.)	Length of Dam (ft.)	Length of lake formed (miles)	Volume of water impounded (acre ft.)	Area of Lake (acres), at top of spillway gates	Head for Power (ft.)	Power installation authorised Sept., 1942 (Kw.)	Ultimate plant capacity (Kw.)
Kentucky	Tennessee ..	160	8,650	184·3	6,100,000	256,000	48		160,000
Pickwick Landing* ..	,, ..	113	7,715	52·7	1,091,400	46,800	43	144,000	216,000
Wilson*	,, ..	137	4,860	15·5	535,000	15,500	95	284,800	436,000
Wheeler*	,, ..	72	6,342	74·1	1,151,000	68,300	48	129,600	259,200
Guntersville* ..	,, ..	94	3,979	82·1	1,018,700	70,700	36	72,900	97,200
Hales Bar*	,, ..	83	2,315	39·9	124,800	5,760	36	51,100	51,100
Chickamauga* ..	,, ..	129	5,794	58·9	705,000	39,400	36	81,000	108,000
Watts Bar	,, ..	97	2,965	72·4	1,132,000	41,600	52	90,000	150,000
Fort Loudoun	,, ..	135	4,835	50·0	415,500	15,500	55	...	128,000
Norris*	Clinch	265	1,860	On Clinch 72 On Powell 56	2,567,000	40,200	155	100,800	100,800
Cherokee	Holston	175	1,689	58·5	1,565,400	31,100	100	60,000	120,000
Douglas	French Broad ..	...	...	43·1	1,540,000	31,600	100	...	120,000
Fontana	Little Tennessee ..	...	...	29·0	1,450,000	10,800	330	...	202,500
Hiwassee*	Hiwassee	307½	1,287	22·0	438,000	6,280	190	57,600	115,200
South Holston ..	Holston	...	...	24·5	783,000	9,100	190	...	75,000
Watauga	,, ...	...	...	16·7	677,000	7,100	225	...	60,000
Appalachia	Hiwassee	...	...	9·8	61,250	1,093	350	...	75,000
Chatuge	,, ...	...	...	11·8	243,000	7,050	...	...	...
Nottely	,, ...	...	..	23·2	189,800	4,430	...	...	...
Ocoee No. 1*	,, ...	135	840	7·5	76,600	1,380	110	18,000	18,000
Ocoee No. 2*	,, ...	30	750	...	...	...	250	19,900	19,900
Ocoee No. 3	,, ...	...	...	...	14,170	518	280	...	27,000
Blue Ridge*	,, ...	167	1,000	10·0	197,500	3,290	147	20,000	20,000
Great Falls*	Caney Fork ..	92	800	22·0	49,600	2,280	142	29,370	29,370
					22,129,820	715,781		1,159,070	2,588,270

"Planning, designing, and constructing the physical works needed to control and utilize the flow of the Tennessee River and its tributaries has been a major concern of the Authority. Each main river project consists of a dam with suitable spillway capacity for regulating floods ; a navigation lock plus provision for the future installation of a second lock ; a powerhouse with initial power generating facilities to utilize the partially regulated flow of the river, and provision for future power installations to take advantage of further upstream and tributary control. Tributary projects are located where they most effectively control destructive floods and increase the

* Even as low a head as 19 ft. has been used.

river flow for navigation and the production of power."

"It is clear, then, that the statute calls not only for multipurpose control of water but for multipurpose use of this water as well. To illustrate: In the river channels the TVA is constructing a series of high dams that will provide a navigable channel for boats of 9-foot draft from the mouth of the river at Paducah, Ky., to Knoxville, Tenn., a distance of 650 miles. These same high dams also provide great storage capacity for the control of destructive flood-waters and at the same time create a vast amount of water power that only needs to be harnessed by turbines and generators to provide abundant and cheap electricity." (The Pickwick Landing, Wheeler, Gunterville, Chickamauga, Norris and Hiwassee dams are designed for flood control as well as power production.)

The total amount of water which these dams, when completed, will be able to hold amounts to 22 million acre-ft. which is about 50 per cent of the run-off, and 20 per cent of the total precipitation. In course of these ten years, 12 dams have been constructed, impounding 8 million acre-ft. of water which is 18 per cent of the run-off. A little thinking shows that it is desirable to have as large a storage capacity as possible. This serves a double purpose. In the case of threatened abnormal precipitation, which would otherwise cause a severe flood, a large part of the precipitation can be caught in the reservoir, and the flood crests can be reduced within safety range. Further, as far as power-generation is concerned, a large fraction of the available power can be converted to "primary power."*

At some seasons, the head of water available for power generation is greatly diminished, and to keep up production, steam turbine generators have to be kept as standbys. The total power of these standbys in 1942 was 346,070 kw. *i.e.*, about 30 per cent of the hydro-power. In an efficiently designed hydro-station this should be as small as possible. The TVA hopes to develop a maximum hydro-power of 2·5 million kw., with a standby steam plant of ½ million kw. The ratio will then be reduced to 20 per cent.

Column 3 of Table I shows the height of each dam, above the dry river bed. The heads for the main Tennessee generating stations range from some 35 to 100 feet, and the total drop utilised comes up to 457 ft. showing that almost the whole of the drop between Knoxville and Paducah is utilised for power generation. It will be seen that the heads available for each station is as low as 35 ft., and on the main river it does not exceed 95 ft.

The dam is a masonry wall of proper design, constructed across the river-bed. To take one example, the Guntersville Dam rises 94 ft. above the river bed, has a length of about 4000 ft., holds about a million acre-ft. of water on the upstream side, and the length of the lake formed is 82 miles. The area flooded by this lake is 70,700 acres, *i.e.*, nearly 110 sq. miles. The maximum power available at this dam site is ninety seven thousand kilowatts, but licence for development of 72,000 kw. has been granted by 1942. The total maximum power which can be developed in the whole TVA area is about 2·6 million kilowatts, of which licence for 1·16 million kws. has been issued in 1942.

The construction of the dams is regarded as great feats in engineering. According to 'Wonders of World Engineers' (p. 917), the lakes formed by these dams involve the rearrangement of hundreds of miles of roads and railways and the building of many bridges in addition to elaborate clearance work in removing settlements, farms, buildings and many thousands of trees. A band of geologists was employed to find out proper bed sites, and inspite of extensive work, good bed rocks were not always found. The bed was prepared by extensive grouting and in certain cases (*e.g.*, the Chickamauga Dam), nearly 40 ft. of sand and clay had to be removed from the bed before the bed rocks could be found. The details of the experience and methods adopted for grouting the foundations has been elaborated at length in the symposium of the American Society of Civil Engineers[4] (see, *Proceedings*, Vol. 66, 1940, pp. 383 to 499).

Table II shows how the production of electricity by the TVA has gone up from 1934. The total pro-

TABLE II

POWER SALES AND REVENUES (TVA 1934-40)

Year	Units consumed (Kwh.)	Mills* per unit	Revenue (dollars)
1934	395,842,000	2·11	835,647
1935	100,608,000	5·95	598,102
1936	437,440,000	2·74	1,198,591
1937	731,648,000	2·30	1,681,406
1938	699,304,000	3·30	2,305,454
1939	1,616,793,000	3·36	5,445,198
1940	3,629,677,000	4·17	15,125,380
1941	5,556,000,000	4·17	21,137,000

* 1 mill = 1/1000 dollar = 1/10 cent (1 cent = ¼ anna, nearly).

Traffic increased from 22 million ton-miles in 1933 to 100 million ton-miles in 1940.

* Primary Power :—The power which is available throughout the year as "steady supply".

Secondary or Surplus Power : The extra power which is available when the reservoir is filled to the full, due to flood water, and water can fall through a larger height, thus generating excess power. It is clear that we have Secondary Power only during flood months.

duction in 1941 was 5,556 million units, which is larger than electrical energy produced in the whole of India by 60%. It is nearly 12 times the amount of electrical energy produced in 'Greater Calcutta' in 1941. Thus the TVA harnesses at present time about 21 per cent of the energy spent by the Tennessee River in its downward course during the year.

The reader will notice a big jump after 1938, and particularly in 1940. The reason was that the TVA could not, before the outbreak of the war, find out a market for its electricity owing to absence of large-scale consumers, and opposition of local electricity supplying companies. On the outbreak of the war, a large channel was found for consumption of power. This is illustrated in Fig. 4. Huge aluminium works, synthetic fertiliser plants, plants for the manufacture of explosives, chemicals, ferro alloys, phosphate plants, and aircraft factories have been installed in this area.* The TVA is making a substantial contribution to 'National Defence'. The total income to TVA from sale of electricity amounted to 21 million dollars in 1941.

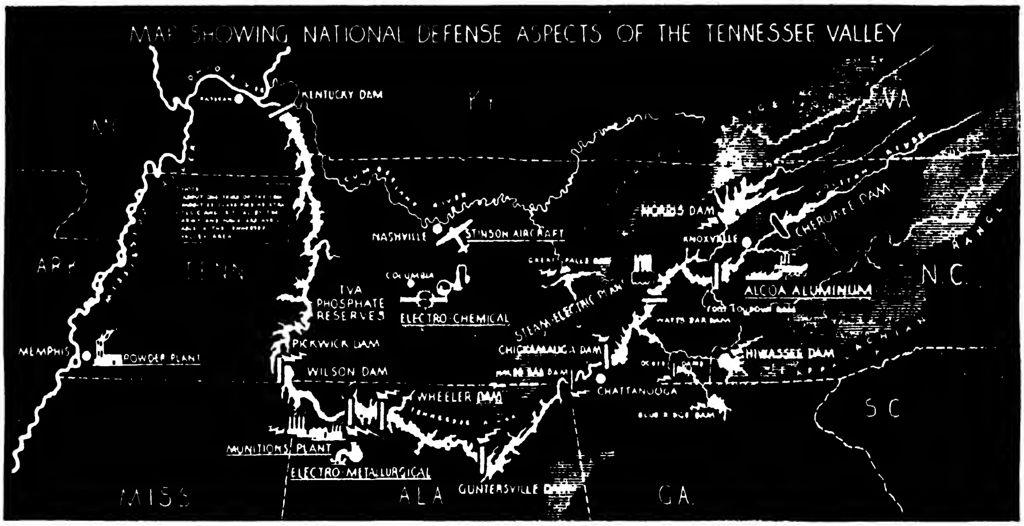

Fig. 4. Industrial development on the Tennessee Valley. *(Reproduced from TVA Report).*

Rural Electrification and Development of Small Industries

The network of the TVA Power lines have made electricity available in the interiors of the rural area enabling the people to enjoy the modern living standards. The cost of the power units for the consumers were lowered with the increase of production and supply of the power. This has eventually led to the opening of small mills, workshops for small industries, and small factories. In fact, the cottage industries have been greatly stimulated by the supply of cheap power. Apart from these, the TVA has organised electrical cold storage units for homes and families who can hire 'lockers' and preserve their foods in them. The use of electric lamps, cooking stoves, room heaters being very much increased, and there has been a grand saving of coal and petroleum. This is of utmost importance from the standpoint of the conservation of the fuel resources of the country.

Dam Sites as Recreation Centres

The reservoirs make excellent places for recreation. These beautiful 'lakes' attract a large number of tourists on the sites, and add considerably to the income of the people of the locality. Motorable road, steam boats, scenic beauty of the surroundings make the site extremely attractive. At the Norris Dam in 1934, some 385,000 visitors and tourists came to enjoy their holidays. It suggests an enormous possibility for developing the place as a valuable recreation centre.

The Organisation and Expenses

The chart (Fig. 5.) on the TVA organisation shows the management of the entire scheme of administration.[2] The TVA organisation consists of 10 departments, which are combined into 5 function-

* The aluminium works alone consume over 1,000 million units; ferro alloys consume a farm power of 56,000 kw., ammonium nitrate plants 38,000 kw.

ally related programme groups, *viz.*, the Management Service Council, Water Control in the River Channel, Water Control on the Land, Power, and Regional Planning Council. The work is co-ordinated in a two-way flow between the Board and the department heads through the Office of the General Manager. Within the limits and objectives set by the Act and the policies of the Board, every department is both a planning and an action unit. To encourage initiative, technicians, professional people, and administrators are allowed maximum latitude for original expression.

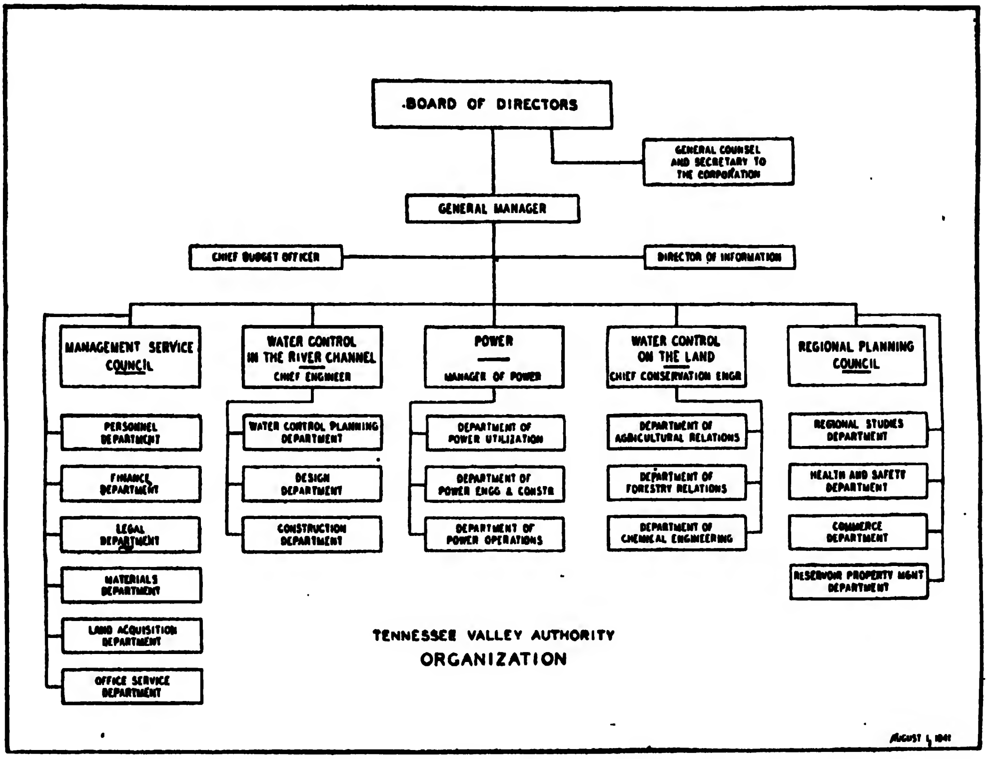

FIG. 5. TVA Organisation. *(Reproduced from the Annual Report, 1941).*

The organisation of the TVA employs a large body of personnel, technically or otherwise expert, including engineers, scientists, architects, machinists, clerks, draftsmen, instructors, teachers, research scholars, doctors, foresters, and so forth. The number of employees under the TVA was 22,506 at the end of the fiscal year 1941. It is interesting to note that about 5,500 of the employees received salaries more than 1,500 dollars a year or about Rs. 375 per month,—they include both skilled engineers and technicians as well as clerks, machinists, carpenters, etc. Jack and Whyte remarks, "Its salary list includes almost every recognized profession and some that would scarcely be recognizable outside the Tennessee Valley." This gives us an idea of the comprehensiveness of the scheme and, Jacks and Whyte record:

"Within eight years, the Tennessee Valley Authority has built thirteen large dams, created 385 miles of 9 ft. navigation channel for commerce, provided more than 8,000,000 acre-ft. of flood control storage, produced nearly 30,000 million kwh. of electric energy, provided 150,000 seedlings for reforestation, and manufactured 500,000 tons of phosphates and fertilizers."

The construction of dams and power-plants have been great engineering as well as economic feats. To mention the cost of a few of them we have the following figures[2]: Pickwick Dam 35,631,000 dollars (includes 4 power-generating units), Wilson 38,695,000 dollars (with 14 units), Wheeler 35,265,000 dollars (with 4 units), Guntersville 31,675,000 dollars (with 3 units), Chickamauga 34,950,000 dollars (with 3 units), Norris 30,856,000 dollars (with 2 units), Hiwassee 17,385,000 dollars (with 1 unit), etc. The projects have already approached an expenditure of 500 million dollars in course of these ten years of the TVA.

SUMMARY

Let us now scrutinize the factors which have contributed to the success of the TVA.

In the first place, the planning was 'totalitarian'. The Authority took the whole river system as 'one unit', and evolved a scheme for dealing simultaneously with problems of flood-control, navigation, electrical power generation, soil conservation, irrigation and public health. No piecemeal measures were undertaken.

There was a 'Roosevelt' behind the schemes, so that the oppositions due to States and vested interests could be overcome, and the full power of the Federal State could be exerted for the success of the undertaking.

The execution of the work was in the hands of trained scientists and engineers, and all constructive works were first tested by means of model experiments in the research laboratories.

"The TVA has adopted a policy of co-operation with Nature; its worst enemies are not natural forces but the interests that have grown powerful on their exploitation. The desert is beginning to blossom again in the Tennessee Valley. Man and Nature are proving a stronger combination than man and money."[1]

The present article was originally compiled for circulation among the members of the Damodar Flood Enquiry Committee which met for its second sitting in March 1944. A few more details have however been added here. Of all the river basins in the world, the Damodar Valley presents the closest parallel to the Tennessee Valley, though on a smaller scale. The radical solution of the problems of the Damodar Valley lies, therefore, in the adoption of similar procedure as has been done by the U. S. Government through the TVA, with necessary modifications.

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PLANT LIFE IN WATER

K. BISWAS
SUPERINTENDENT, ROYAL BOTANIC GARDEN, CALCUTTA

WATER is the sustainer of life. Creation proceeded from water, so say the sacred books of India. About three-fourths of the globe are water and many "unfathomed caves of ocean" bear numerous plant and animal organisms which originate, grow and die in the depths of the seas. The remains of some of them are preserved for ages as fossils. Thus in some of the beds of the oceans have been discovered vast areas covered with deposit of fossil remains of the most remarkable unicellular plant known as Diatom. These unicellular plant organisms bear on their silicified walls markings of extraordinary beauty. Very large plants sometimes appearing like palms also grow deep down on the bed of the ocean covering large areas. They are of various colours mostly red and brown. These plants of the marine waters are commonly known as seaweeds. These seaweeds which are truly the "treasures of the deep" exhibit marvellous display of colour and designs in their fronds which serve as objects of art. The seaweeds are distinguished according to their variation in colouring matters. Thus Blue-green seaweeds are known as Myxophyceæ or Cyanophyceæ; Green ones are called Chlorophyceae, Brown—Pheophyceae and Red—Rhodophyceae. Some of the members of a brown seaweeds attain enormous size. Some are submerged while others are exposed to the tidal water. The colour of the seawater which is sometimes red, brown, greenish grey, blue-green, etc. is due to the presence in large masses of plants and animal organisms which float freely on the surface drifted by the current of the water and wind. Such a floating mass of organisms is known as plankton. They are popularly known as water flowers. The red colour of the water of the Red Sea, especially near the coast is due to the radiant appearance of the floating microscopic plant known as *Trichodesmium erythraeum.* Another microscopic alga—*Nodularia spumigena*—imparts greenish grey colour to the Baltic Sea. Similarly the colouration of the Atlantic Ocean near the tropical region is due to the presence of myriads of organisms known as *Heliotrichum.* Some Diatoms occurring in large masses, lend brownish or greenish tints to the Arctic seas. Luminiferous plankton forms of the marine floating plant organisms known as dino-flagellata occurring

in the North Sea, Skager-Rak and Western Baltic render the seawater phosphorescent in the autumn. Green, blue-green and red colouration of the fresh water tanks, jheels, ponds and puddles is caused chiefly by water flowers. These water blooms are composed of minute microscopic unicellular free floating green and blue-green water plants. The thin green film frequently noticed in our tanks and ponds is caused by plant organisms known as Euglenas which swim rapidly in the surface water and change its colour from green to red caused by the variation in the intensity of light.

The current water of rivers and streams etc. do not harbour sufficient vegetation. Strong current, the amount of pollution and influence of tide are so much that the physical forces such as gravity and light, the chemical forces such as oxidation and reduction, and other physico-chemical operations and the biological forces such as the action of bacteria, the water plants known as algae and the lower aquatic animals favourable to sustaining rich vegetable life—are all reduced to a minimum. The biotic factors also interfere with the plant and animal life of such flowing waters.

In clear hill streams submerged and rock-loving plants are often seen attached to the rocks and other hard substrata. The plants found in such a peculiar situation belong to the genus *Podostemon* of which *P. Wallichii* is often met with on the rocky submerged beds of hill streams in different parts of India. A microscopic blue-green plant known as *Stegenima* and the two red ones of the genera *Siriodolia* and *Batrochospermum* are also found to occur in similar habitat to that of *Podostemon*. These lithophilous *i.e.*, rock-loving plants show extraordinary adaptations to their peculiar environments.

Let us now pass on the freshwater plants which are so plentiful in this country. Anyone, even a casual rambler, walking along the banks of a lake, a jheel, a tank, a pond, or a puddle, and observing plants and animals floating, swaying, dancing and playing in the water in their natural beauty, cannot but wonder at the marvels of pond-life, and will find in them "complete expression of the will of God in things created." He will then surely try to peep into the secrets of "organic creation in the midst of which our lives are embedded."

In a sweet water reservoir overgrown with vegetation we find generally four distinct storeys of vegetation. On the muddy floor of our tanks, jheels, lakes, canals, khals and numerous other similar water areas there exist a thin film of slimy layer of mud over the floor of the tanks, jheels, etc. Such a muddy floor consists of numerous microscopic plants and other allied organisms such as putrefaction bacteria, sulphur bacteria, iron bacteria, Diatoms and blue-green algae. Such a layer harbouring so many types of life forms in the bottom of water areas is known as the vital layer. The organisms of this vital layer are of great biological importance as they disorganise large quantity of organic matters deposited on the muddy bottom by the submerged plants and animal organisms as a result of their metabolic action. Such a debris of decaying organic matter is finally converted into suitable plant foods for rooted aquatics and submerged plants.

Next comes larger flowering aquatic plants which are rooted to the bottom layer. One of the most common plants is known as *Vallisneria spiralis* (পাটাবাবি). It has long ribbon-shaped green leaves and an underground trailing stem rooted at the nodes to the mud. In this plant the male and the female flowers are born on two separate individuals. Towards the end of the cold weather from February to April, the female plant shoots out a long spirally coiled threadlike stalk bearing at its apex female flowers with the stigma or the receptive spot floating over the surface of the water. The male flowers in their turn bursting out of the sheath at the base of the plants come up and float over the surface of the water in large numbers. The male germ then reaches the female organ by the current of water and fertilisation takes place resulting in fruits containing seeds. There are some other rooted aquatics of similar habit. Next storey of water plants is composed of floating and submerged vegetation and finally, if the surface of the water of a tank, a lake or a jheel etc. is left uncared for, there grow various types of floating and amphibious plants. If, however, the surface of the water is fairly clean the vegetation may be composed of non-flowering microscopic water plants or minute flowering plants such as *Wolfia* (guri pana), *Lemna* (khudi pana) and *azola* serving as the chief source of food to our edible fishes. But these delicate floating plants are easily replaced by larger sturdy members of higher orders such as *Pistia stratiotes* (toka pana), *Salvinia cucullata* (idurkani pana) and water hyacinth (kochuri pana). If these larger plants are not taken out of the water, the surface of an expanse of water, with the support of these larger floating plants, may then gradually be encroached upon by what may be called amphibious vegetation. The members of this community of water plants are partly attached with their roots to the sides of the tank and partly suspended over the surface of water by various adoptions. Of these may be mentioned *Jussieua repens*, *Ipomoea reptans* (kalmi sak), *Enhydra fluctuans* and *Hygrorhiza aristata* and others. A thick screen of such a floating vegetation chokes up the surface of the tank and prevents sunlight from penetrating into the water. It thus interferes with the photosynthetic action of the submerged water plants imparting oxygen to the water and thereby purifying the water.

When these larger plants have their free hold over the surface of the water, the internal conditions of the tank then become highly insanitary and prove to be deleterious to culture of fishes. In addition to this kind of water plants there are other types of water plants which have underground stems rooted in the muddy bottom of the tanks and the leaves float over the surface of water. The common plants of this type are Lotus, Lily, Limnanthemum, Paniphal and others. Of such plants the most interesting plant of horticultural importance is the giant water Lily—Victoria Rigia—called after Queen Victoria. This Amazon Lily, the largest flowering aquatic plant has very large leaves about 6 to 9 feet in diameter with flowers as large as 1 foot in width. It opens early morning but closes up soon after. At the beginning of its bloom it is white but later on it becomes pale pink. A freshly opened flower effuses a very sweet fragrance.

The water plants both of the sea and fresh water are of great economic importance. Microscopic green and blue algae and diatoms play an active part in the purification of water, irrigation and drainage. Larger floating plants like the water hyacinth and other water plants and the filamentous microscopic forms of plants often provide obstacles for effective operation of irrigation systems and lead to various biological problems affecting health and communication of people. The role of algae in the filter works of Calcutta and other cities has been clearly established in my works on the algae of the filterbeds. The relation between lower aquatic plant organisms and mosquito larvae is an important problem in our country.

Seaweed is also a valuable food containing silica, lime, potash, nitrogen and carbon. They are also good manure and are utilised as such along the coastal regions. It is worthwhile to investigate this aspect of the importance of seaweed in India along her coastal regions. The well-known Ceylon-moss or Agar Agar used as food and culture medium for bacteria and fungi is a kind of seaweed. Another seaweed which is likely to grow in some parts of our coastal areas in Southern India is cultivated for food in Japan which is known as Japanese 'Laver'. It is imported into England in dried sheets. War has made seaweed eaten in many forms in different parts of Britain. "Seaweed bread", sometimes called "laver bread", made from Puple Laver seaweed known in science as *Porphyra vulgaris* is popular on the Welsh coast. Dulse, a species of small, smooth leaved seaweeds botanically called *Rhodomenia palmata* is eaten uncooked in some parts of Great Britain. In some of the coastal areas of England it is served with roast mutton or as a savoury on toast. Another seaweed *Lamminaria saccharina* is eaten in Ireland and in Japan as a delicacy and is particularly prized as "the poor man's weather guide" for a tuft suspended to the ceiling will foretell rainfall by its absorption of the coming moisture. Other industrial uses of the seaweeds, such as for sound deadening, heat and cold insulation, manufacture of iodine etc., are of increasing importance in trade. Fossil beds of Diatoms or Diatomaceous earth may be discovered in the neighbourhood of the Andaman and Nicobar Islands. Diatomaceous earth is of great importance as a commercial product. Researches reveal its varied uses for industrial purposes particularly for the manufacture of an explosive, dynamite, that could be transported with comparative safety. The marine and freshwater plankton algae are the chief food for fishes and are therefore of the greatest value to pisciculture. The great importance of algae in relation to fisheries has been proved by the recent investigation carried out in many leading Marine Biological Stations where algae in relation to fishes and freshwater supply are studied. "It is well-known", emphasises Polunin, the reputed biologist, "that many macroscopic animals, such as fishes and seals which are important for man's food and fuel, are to a very large extent dependent upon plankton ultimately and indirectly phytoplankton for their own food." He rightly insists on the war-time use of plankton, as there is sufficient possibility of 'obtaining food direct from the marine plankton'. My own investigation too fully establishes the importance of some forms of algae in pisciculture and sanitation of our water areas.

The plant life in water is a world by itself. Its mutual relation with aquatic animal organisms is also of great importance. Recent biological advancement compels the biologists to explore all avenues to utilising the vast marine and freshwater plant and animal organisms. India should not lag behind in such an effort. Limnological researches will reveal, as a result ot further investigation, mysteries of plant and animal life in the marine and sweet water which are likely to have direct or indirect bearing on human life as well.

"Then study her with reverence high, and she will give the key,
So shalt thou learn to comprehend to the secrets of the sea."

MARIE J. EWEN.

INDIAN HISTORY CONGRESS

The Project for a Comprehensive History of India

BISHESHWAR PRASAD,
JOINT SECRETARY, INDIAN HISTORY CONGRESS

THE demand for a Comprehensive History of India has been voiced by scholars for sometime now. The absence of a common forum of Indian historians, however, prevented this demand from assuming a concrete shape until the Indian History Congress was founded in 1935. At its very first session held at Poona the Congress realised the need and emphasised the early desirability of mobilising the country's talent for the purpose. At its second session in 1938 at Allahabad a Committee was appointed to examine the feasibility of preparing a Comprehensive History of India, written along objective and scientific lines by Indian historians. The Committee reported favourably and the Congress, thereupon, decided to undertake the work at its Lahore session. The first task was the preparation of an agreed synopsis for the projected history. A number of drafts were prepared and closely scrutinised by some eminent historians of the country. It was then decided to appoint three editorial committees to reconsider the draft scheme, divide it into volumes and chapters and to assign chapters or sections of chapters to scholars who were to be selected on the basis of their special work on the subject covered by the chapter allotted to them. Each Committee was to deal with one period of the history—ancient, medieval and modern. The Editorial Committees* were composed of some leading historians, who had made a mark in their respective fields, and, as will be clear from the lists below, are representative of the various sections and areas of the country. The conveners of these Committees respectively are Dr R. C. Majumdar, ex-Vice-Chancellor of the Dacca University, Dr R. P. Tripathi, Professor and Head of the Department of History, Allahabad University, and Dr S. N. Sen, Keeper of Imperial Records, Government of India, New Delhi. Besides, a Coordinating Committee† was appointed to coordinate chapters and periods and ensure uniformity of treatment and unity of design. Dewan Bahadur Dr S. Krishnaswami Aiyangar, Retired Professor of History of Madras University, was appointed its Chairman. It consists of the three conveners of the Editorial Committees besides Prof. Srinivasachari, Dr Tara Chand, General Secretary of the Congress

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* The personnel of the *Editorial Committees* is as under:

Ancient Period

1. Dewan Bahadur Dr S. Krishnaswamy Aiyangar, M.A., Ph.D., Madras.
2. Dr D. R. Bhandarkar, M.A., Ph.D., Calcutta.
3. Dr H C. Raychaudhuri, M.A., Ph.D., Carmichael Professor of History, Calcutta University.
4. Dr R. K. Mukerji, M.A., Ph.D., Head of the History Department. Lucknow University.
5. Dr M. H. Krishna, M.A., D.Litt., Head of the History Department, Mysore University.
6. Dr A. S. Altekar, M.A., D.Litt., Head of the Department of History and Indian Culture, Benares Hindu University.
7. Prof. K. A. Nilkantha Sastri, M.A., Head of the History Department, Madras University.
8. Rao Bahadur K. N. Dikshit, Director General of Archaeology, Simla.
9. Dr R. C. Majumdar, M.A., Ph.D., Calcutta (*Convener*).

Medieval Period

1. Prof. Mohammad Habib, M.A., Head of the History Department, Aligarh University.
2. Prof. H. K. Sherwani. M.A., Head of the History Department, Osmania University, Hyderabad.
3. Dr Ishwari Prasad, M.A., D.Litt., Allahabad University.
4. Mr G. Yazdani, Director of Archaeology, Hyderabad, Deccan.
5. Dr Tara Chand, D.Phil., K. P. University College, Allahabad.
6. Dr K. R. Qanungo, M.A., Ph.D., Head of the History Department, Dacca University.
7. Dr B. P. Saksena, M.A., Ph.D., Allahabad University.
8. Dr R. P. Tripathi, M.A., D.Sc.. Head of the History Department, Allahabad University (*Convener*).

Modern Period

1. Prof. D. V. Potdar, Bharat Itihasa Samshodhak Mandal, Poona.
2. Rao Bahadur Prof. C. S. Srinivasachari, M.A., Head of the History Department, Annamalai University.
3. Principal Sita Ram Kohli, M.A., Government College, Hoshiarpur.
4. Dr K. K. Dutta. M.A., Ph.D., Patna University.
5. Dr Bisheshwar Prasad, D.Litt., Allahabad University.
6. Dr S. N. Sen, Ph.D., B.Litt., Keeper of Imperial Records, New Delhi (*Convener*).

† The Personnel of the *Coordinating Committee* is as follows:

1. Dewan Bahadur Dr S. Krishnaswami Aiyangar (*Chairman*).
2. Dr R. C. Majumdar, M.A., Ph.D., Calcutta.
3. Dr R. P. Tripathi, M.A., D.Sc.. Allahabad University.
4. Dr S. N. Sen, Ph.D., B.Litt., New Delhi.
5. Rao Bahadur Prof. C. S. Srinivasachari, Annamalai University.
6. Prof. H. K. Sherwani, M.A., Osmania University.
7. Dr Tara Chand, D.Phil., Allahabad.
8. Dr Bisheshwar Prasad, D.Litt.. Allahabad University (*Secretary*).

and Prof. H. K. Sherwani. Dr Bisheshwar Prasad was appointed to act as its secretary. These Committees, permanent in their constitution, are responsible for the preparation and editing of the Comprehensive History.

The Editorial Committees could in the early stage, proceed with their work only by means of correspondence. At Aligarh, in December, 1943, during the last session of the Indian History Congress, the three Committees met and finally adopted the scheme of the Comprehensive History of India in 12 volumes, which secured the approval of the Coordinating Committee also. The Editorial Committees also discussed a time table for the preparation of the volumes, and it was resolved to bring out at least two volumes in the first year, and to publish at least three volumes every subsequent year. Thus it is hoped that in four years the Comprehensive History of India will be completed. To facilitate the work of editing, it was also decided to assign one volume to one member of the Editorial Committee, who will help the Committee in the editing of the volume concerned. The following arrangement was agreed upon:—

Vol. I: From the earliest times up to 325 B.C. including account of Indus Valley Civilisation.
Rai Bahadur K. N. Dikshit.

Vol. II: From the Mauryas to the rise of the Guptas (325 B.C. to 319 A.D.).
Prof. K. A. Nilkantha Sastri.

Vol. III: From the Guptas to the rise of the Cholas in the South, and Paraman in the North (319 A.D. to 985 A.D.)
Dr R. C. Majumdar.

Vol. IV: From 985 A.D. to the establishment of Turkish domination (1206 A.D.)
Dr S. Krishnaswamy Iyengar.

Vol. V: The Sultanate of Delhi (1206 A.D.—1326 A.D.) and Provincial Kingdoms.
Prof. M. Habib.

Vol. VI: Administrative and Cultural Aspects in the Period 1206–1526 A.D.
Dr Tarachand.

Vol. VII: Political History of the Mughal Period (1526—1717 A.D.)
Dr R. P. Tripathi.

Vol. VIII: Cultural and Administrative Aspects of of the Mughal Period.
Prof. Sri Ram Sharma.

Vol. IX: Fall of the Mughal Empire and Rise of the Marathas etc. (1702—1772 A.D.)
Dr S. N. Sen.

Vol. X: Disruption of the Maratha Confederacy and establishment of British rule in India (1772—1818 A.D.).
Prof. C. S. Srinivasachari

Vol. XI: Consolidation of the British domination of India (1818—1857 A.D.).
Dr K. K. Datta.

Vol. XII: New India (1857—1919 A.D.).
Dr Bisheshwar Prasad.

Every volume will have on an average about 20 chapters. The size of a chapter will depend on the importance of the subject, but generally a chapter will comprise about 40 pages of 500 words each.

The first volume will open with a description of the culture of the earliest people, and describe the Indus Valley and the early Dravidian civilizations. The history and civilization as depicted in the Vedic Samhitas and post-Vedic literature will be treated in three chapters. Then will follow chapters on the religious movements, Jainism, Buddhism, Vaishnavism, Saivism etc. The history of Aryan expansion in the South and the political history of the period upto the end of the Nanda Empire will be dealt with in another three chapters. Then will follow chapters on social and political institutions, economic conditions, language and literature, art and architecture of the period. Similarly volume two will deal with the history of the Mauryas, their successors in the north, the Satavahana Empire and other dynasties and States of the South and the North which flourished in the period preceding the establishment of the Gupta Empire. Next will follow chapters relating to colonial and cultural expansion, political and social institutions, economic conditions, religious movements, art and architecture, of the period. These aspects will cover about half the volume. In volumes three and four also similar treatment has been adopted. The rise and fall of the Gupta Empire, together with the history of the dynasties succeeding it, as well as the history of the provincial kingdoms and dynastics of the Southern India and the rise of the Rajput clans form the subject matter of the third volume. The fourth volume will narrate the history of the Chola Empire and of the Yadavas of Deogiri, Hoysalas of Mysore and Pandyas of the South. The Chalukyas and other dynastics of the Deccan, Vaghelas, Chandellas, Tomaras, Chauhans, Gahadvals, Palas and Senas, all these dynastics will find due mention in the pages of this volume, which will describe the political condition of our land on the eve of the Turkish invasions from the north-west. In both these volumes a large number of chapters will be devoted to the discussion of colonial expansion, religious movements, social and economic life, political institutions, art and literature of the period.

The entire Medieval Period from 1206 to 1712 has been divided into two well marked epochs, the Delhi Sultanate and the Mughal Empire, each having two volumes to itself. In volume five while half the chapters will be devoted to the narrative of the political history of the Delhi rulers, the other half will chronicle the rise of the many provincial States which trace their growth to the disruption of Delhi supremacy. The States of Jaunpur, Bengal, Gujrat, Malwa and Khandesh besides the Bahmanide and Vijayanagar Empires of the South and the Rajput States of the North will be dealt with in the remaining chapters. But volume six will be wholly devoted to the discussion of the political organisation, social and economic conditions of the people, religious movements both Hindu and Muslim, and art and literature of the age. The evolution of the provincial languages will also feature prominently. The political and social institutions of the Bahmanide and the Vijayanagar Empires will be dealt with in a few chapters. Thus while the fifth volume will deal with the political history of the period, volume six will cover the cultural and institutional developments of the epoch. The same treatment has been adopted for the next two volumes dealing with the history of the Mughal Empire from 1526 to 1712. In the first volume (Vol. VII) earlier chapters will narrate the expansion of the Mughal Empire, while later chapters will relate the rise of the Marathas, Sikhs, Jats and Bundelahs whose emergence led to the disruption of the Mughal Empire. The last few chapters will deal with the policy of the Mughal Emperors towards the Rajputs, and their religious policy. The history of the disruption of the Bahmanide Empire and the succeeding States, as well as the South Indian States which succeeded Vijayanagar Empire and the story of the European settlements will also be narrated in this volume. The second volume (Vol. VIII) will have chapters on political organisation, revenue system and judicial machinery of the Mughals and the political institutions of the Marathas. Social life, economic organisation, religious life, literature, art—all aspects of cultural life of the country will be treated in this volume.

The period from 1712 to 1919 has been divided into four volumes. The first (Vol. IX) will describe the decline of the Mughal Empire under the successors of the Imperial Mughals, and trace the history of the provincial States which rose on its decline, such as Bengal, Oudh, Deccan and, Rohilkhand. The struggles of the Sikhs, and the history of the Rajputana States have a chapter each. Then will follow chapters dealing with the rise of the Peshwas, foundation and expansion of the Maratha Empire upto the death of the last of the great Peshwas, Madho Rao. The last few chapters will describe the conflicts of the European Companies and the establishment of British control over Bengal. In the second volume (Vol. X) will be narrated, in the earliest chapters, the developments in Maratha polity, the disruption of their Confederacy and the decline and fall of their empire. Then will follow an account of the North Indian States and the history of Mysore and other South Indian States of the period. The subsequent chapters will describe the foundation of the British Empire in India, and the evolution of its administrative machinery. The last few chapters will deal with the social and religious life, economic conditions, art and literature of the eighteenth century. In volume XI after describing the history of the Punjab and of the other States in India, the story of the expansion of the British Empire will be related. The relations of the Company's Government with the Indian States, and the Mutiny will have a chapter each. Next will follow chapters dealing with the evolution of Governmental system and administrative machinery. The last few chapters will again discuss the social, religious, economic, literary and artistic aspects of the early nineteenth century. The last volume (Vol. XII) will describe the developments which have led to the emergence of the New India. Discussion of administrative developments, both moral and material, such as education, press, communications, etc. will be followed by an account of the structure of Government including the growth of the legislature and the evolution of administrative machinery. Then will follow chapters dealing with the financial aspects and the industrial revolution in the country. The movements of religious and social reform, as well as the beginnings of the national political movement will have an important place in this volume. The administrative progress in various States will be described, followed by a discussion of the relations between the paramount authority and the Indian princes. The frontier policy both in the north-west and in the north-east will be discussed in a few chapters. The volume will close with the story of the development of literature and renaissance of arts.

Thus not merely the story of the political vicissitudes will be related but equal attention will be given to institutional and cultural developments. The pomp and splendour of kingdoms and empires will be there, and the narrative will contain deeds of heroism and adventure which won renown in battle and siege, and acts of statesmanship by which great structures of Government and administration were built and the happiness and well-being of the subjects secured. But there will be ample account of the leaders of thought and of faith whose dominion extended over the minds of men and who won lasting empires over their hearts and souls. Nor shall be neglected the study of those creative works of our people which enshrine our ideas of truth and beauty. In these pages will be found not only a narrative of

the rise and fall of empires, but also the history of the religious life and movements, social and economic institutions, political organisation, and development of languages and literature and of art and architecture. The volumes will thus provide a unity of conception which will be expressed through a uniformity of treatment.

These volumes will be embellished by maps, charts, diagrams, and illustrations of our archaeological and artistic heritage. Exhaustive bibliographies relating to every chapter will also be included.

The preparation and publication of the great work will be an expensive undertaking which will involve many problems of finance and administration. For this purpose an Executive Board* has been constituted with a number of public men, administrators, and Vice-Chancellors as its members besides the members of the Coordinating Committee.

The Comprehensive History Scheme is estimated to cost about four lacs of rupees. The Executive Board is already busy collecting funds. The Government of India have granted Rs. 10,000 and the Government of the United Provinces have made a grant of Rs. 2,000 for the year 1944. The Universities of Allahabad and Patna have given a sum of Rs. 5,000 and 2,500 respectively. Thus a good beginning has been made. It is hoped that the Provincial and State Governments, the Indian Universities and industrialists, merchants, zemindars and professional men will also extend their generous support to the Congress.

The Comprehensive History of India is a national undertaking in every sense of the term. Its contributors are drawn from all the Universities of India. They belong to the various great communities of the country, Hindu, Muslim, Parsi, Christian, Sikh, etc. and are fully representative of all the areas and interests. It is, therefore, hoped that the princes and people of the great Indian nation will contribute generously to make the publication of the Comprehensive History of India by their own historians possible.

* The *Executive Board* consists of the folllowing:

1. The Rt. Hon. Sir Tej Bahadur Sapru, P.C., K.C.S.I., LL.D., 19, Albert Road, Allahabad (*Chairman*).
2. The Rt. Hon. Dr M. R. Jayakar, P.C., LL.D., B.C.L., Winter Road, Bombay.
3. Sjt. K. M. Munshi, 26, Ridge Road, Malabar Hill, Bombay.
4. Hon'ble Sardar Sir Jogendra Singh, Kt., Member for Education, Government of India, New Delhi.
5. Dr Sir Shafaat Ahmad Khan, Kt., D.Litt., High Commissioner for India in South Africa.
6. Pradhan Shiromani N. Madhava Rau, C.I.E., Diwan of Mysore.
7. Sir Mirza Ismail, K.C.S.I., Prime Minister, Jaipur State.
8. Nawab Ali Yawar Jung Bahadur, M.A., Secretary to H. E. H. the Nizam's Government, Hyderabad Deccan.
9. Sir Abdul Qadir, Bar-at-Law, Chief Justice, High Court, Bahawalpur.
10. Sir S. Radhakrishnan, D.Litt., F.B.A., Vice-Chancellor, Benares Hindu University.
11. Dr Sir Ziauddin Ahmad, D.Sc., Vice-Chancellor, Muslim University. Aligarh.
12. Dr Sachchidanand Sinha, D.Litt., Vice-Chancellor, Patna University.
13. Prof. Amaranatha Jha, M.A., D.Litt., Vice-Chancellor, Allahabad University.
14. Dr Shyama Prasad Mukerji, 77, Asutosh Mukerji Road. Calcutta.
15. Dewan Bahadur Dr S. Krishnaswami Aiyangar, M.A., Ph.D., Madras.
16. Dr R. C. Majumdar, M.A., Ph.D., 4, Bipin Pal Road, Calcutta.
17. Dr R. P. Tripathi, M.A., D.Sc., Head of the History Department, Allahabad University.
18. Dr S. N. Sen, M.A., Ph.D., B.Litt., Keeper of Imperial Records, New Delhi.
19. Rao Bahadur Prof. C. S. Srinivasachari, M.A., Head of the History Department, Annamalai University.
20. Prof. H. K. Sherwani, M.A., Head of the History Department, Osmania University, Hyderabad Deccan.
21. Dr Bisheshwar Prasad, D.Litt., History Department, Allahabad University.
22. Dr Tara Chand, D.Phil., Principal, K. P. University College, Allahabad (*Secretary*).

Notes and News

OBITUARY

LT.-COL. SIR DAVID PRAIN

According to a Reuter message, death has occurred of Lieutenant Colonel Sir David Prain, C.I.E., F.R.S., the eminent botanist and authority on Indian Flora at the age of 77. India owes a debt of gratitude to Sir David for his significant contribution to the knowledge of Indian Flora, and as such his death will be grieved by botanists all over this country.

Lt-Col. David Prain began his career as a demonstrator in anatomy at the Edinburgh University. He then joined the Indian Medical Service and was attached to native regiments in various parts of India for two years. He was afterwards appointed Curator of the Herbarium and Library at the Calcutta Royal Botanic Garden, in which capacity he served for 11 years. He succeeded Sir George King as Superintendent of the Garden and later he became the Director of Botanical Survey of India. Sir David Prain was instrumental for the introduction of cinchona cultivation in India. He joined the Lhasa Mission in 1902 and in that connection made intensive studies of the flora of Tibet thus contributing largely to the scanty botanical knowledge of the country. He was the trustee of the Indian Museum and in 1905 was appointed Director of the Royal Botanic Gardens at Kew--a post which he held for 17 years.

POST-WAR EDUCATIONAL DEVELOPMENT IN INDIA

The Central Advisory Board of Education have recently submitted their final scheme for post-war educational development in India to the Reconstruction Committee of the Viceroy's Executive Council. The full text of the report signed by 34 distinguished educationists including Sir Jogendra Singh, Chairman of the Board, Mr John Sargent, Educational Adviser to the Government of India, representatives of the Provincial Governments and other members, has now been published by the Bureau of Education for general information.

The scheme is largely based on the memorandum prepared by Mr John Sargent, which was already made public when the Educational Adviser chose this as the subject for his presidential address for the section of Psychology and Educational Science at the last session of the Indian Science Congress. In a note in the February issue of our journal, we already drew the attention of our readers to the twelve points of Mr Sargent's scheme and commented on the financial issue raised by the scheme. The Central Advisory Board have also discussed and formulated plans for post-war education under the following twelve subjects: (1) Basic (Primary and Middle) Education, (2) Pre-Primary Education, (3) High School Education, (4) University Education, (5) Technical, Commercial and Art Education, (6) Adult Education, (7) The Training of Teachers, (8) The Health of the School Child, (9) The Education of the Handicapped, (10) Creative and Social Activities, (11) Employment Bureaux, and (12) Administration. Compulsion, according to the scheme, will be applied between the ages of 6 and 14. Primary and middle education will be free. Entry to high schools will be on a selective basis; generally those pupils will be admitted who show promise of taking full advantage of the education provided. High schools will be of two main types: academic and technical. The objective of both will be to provide good all-round education combined with some preparation in the later stages for the careers which pupils will enter on leaving schools. In the sphere of University education, it is suggested that a committee should co-ordinate the activities of the various universities in order to avoid over-lapping and to maintain standards and should also allocate any grants provided by the Central Government in aid of substantial new developments. It also meets the requirements of the country for technical education side by side with practical training. The scheme lays special emphasis on the quality of teachers at every stage of national education and recommends proposals for improving both recruitment and training.

The scheme is spread over 40 years. During the first five-year or the preparatory period, the bulk of the expenditure will be organising personnel, experiment and research and in establishing colleges and schools for training teachers of different types. Thereafter, the incidence of expenditure will depend largely on the expansion of the high school system. It is estimated that the increased cost of education will be Rs. 10 crores in the first five years, Rs. 23 crores in the tenth year, and Rs. 60 crores in the 20th year. The peak expenditure of the scheme will be reached about the 40th year when the approximate incidence of the increased cost of education is estimated at Rs. 312 crores gross on Rs. 277 crores net per annum.

DESTRUCTION OF THE BERLIN HERBARIUM

In a note in *Science*, December 3, 1943, E. D. Merrill, Director of the Arnold Arboretum of Harvard University, presents an account of the destruction of the famous Berlin Herbarium as a result of the recent Allied bombing of Berlin. Announced in June 1943, the report has been confirmed by the U. S. State Department. The various reports received in America as a result of enquiries through neutral countries, specially Switzerland, bear ample testimony to the severity of the destruction. For instance, the director of the Jardin Botanique at Geneva, Switzerland, was officially informed of the destruction of all its materials on loan to the Berlin Herbarium by fire and water.

The destruction of the Berlin Herbarium, one of the largest and most important of all herbariums, represents a major catastrophe for the world of science. The botanical world will genuinely regret this irrepairable loss which largely appears to be the outcome of indiscriminate bombing. The herbarium was developed and equipped through the efforts of distinguished German botanists, which extended over a period of nearly two centuries. It housed the basic historical collections of Germany outside those at Munich and hundreds of thousands of type specimens from all parts of the world. Dr Merrill has revealed that about 4,393 specimens from different American herbariums alone were lying in the Berlin Herbarium on loan basis, all of which can now be taken to be destroyed. It is reasonable to expect that loans from other countries also assumed proportional figures. As a matter of fact, inter-institutional loan system of study materials has been developed in this country to a great extent leading to international co-operation of inestimable value in science. Dr Merrill genuinely feels that while the loss of certain selected collections from American institutions on loan in Berlin will be felt by workers in American herberia, the really irreplaceable loss is that of the Berlin Herbarium itself.

It is fitting to recall in this connection the destruction of the famous Pulkovo Observatory in November 1941, during the Nazi bombing of Leningrad. Men of science will always regret destruction of institutes of scientific research and development, developed through centuries of strenuous and untiring effort of the best brains of all times. Despite the professions of high and fascinating ideals, the war will lose its very meaning and purpose if it fails to protect these institutes from which alone truth, knowledge and suggestions for progress ever emanate.

INDIAN LAC RESEARCH INSTITUTE

The annual report of the Indian Lac Research Institute, Namkum, India, for the financial year 1942-43, contains the Director's review of the Institute's work under Administrative, Chemical, and Entomological sections. The work of the Chemical and the Entomological sections of the Institute, however, continued to be satisfactory during the year under review despite various difficulties created by the war. As usual the Chemical section concentrated largely on moulding powders, varnishes, shellac rubber combinations, fundamental researches etc., but was mainly concerned during the year, with improvements of several processes that may lead to important commercial development. Mention may be made of the shellac moulding powder factory which already started production. Laminated paper-boards have been successfully produced on a commercial scale. Large-scale manufacture of grinding wheels, waterproof emery paper, and injection moulded articles has also been demonstrated. An insulating varnish suitable for enamelling bare copper wire was developed. The erection of a pilot plant for the manufacture of formaldehyde was completed, and experiments are now in progress to determine the best working conditions for satisfactory yield. The problem of preparing urea either in small or in large quantities has been solved by a new method of making the same from ammonium carbonate instead of from ammonium carbonate. The Chemical section's fundamental researches during the year include investigations on preparation of pure resin from shellac, determination of age of shellac, solubilization of dyes, effect of temperature and humidity on lac, dipole moment measurements, dielectric properties of lac constituents, instantaneous sound recording discs etc.

The Entomological section concentrated particularly on the improvement and extension of cultivation by demonstration and advice. The officiating entomologist inspected and drew up working plans for improved cultivation for a large number of Indian States and Zemindaris. Arrangements have been made to depute senior fieldmen from the Institute to serve for 3 years at important centres in fairly large States, where the authorities are willing to pay for such services. The various investigations carried on under this section, during the year under review, include mortality and fertility in lac insects, artificial control of insect enemies by heat treatment, improvement of cultivation of *Palas*, biological control of predators on *Kusumi* and *Rangeeni* crops, mass breeding of M. greeni and M. Hebetor in the laboratory etc.

A QUESTION ON INDIAN PATENT RIGHTS

In a letter recently addressed to us, Mr S. G. Sastry, Director of Industries and Commerce (retired), draws our attention to the question of obtaining patent rights in British India for a particular invention

or a process already patented in foreign countries. Mr Sastry had of late an occasion to have some correspondence with Controller of Patents in Calcutta on this matter which is doubtless important to Indian scientific workers. He raised the question whether a process or an apparatus already described in current technical literature and patented outside India could be given patent rights in this country. The Controller of Patents has given a ruling on this subject and has permitted him to quote the relevant portions from the letter, of which we have received the following extract for publication.

"The question is 'can any one apply for a patent if a particular invention or if a particular process which is known in other countries happens to be either unknown or little known in British India'. The answer to this question is that prior knowledge or prior use of an invention outside British India is not a bar to the grant of a patent in British India if the invention has not been publicly used or publicly known in any part of British India, prior to the date on which the application for a patent was made in this country. An invention is deemed to be publicly known if a document containing an adequate description of it, whether issued as a general publication or not, has in the course of ordinary business and without imposing any secrecy, reached an appreciable section of the public interested in the art to which the invention relates."

PROBLEM OF SOAP MANUFACTURE IN INDIA

At the 10th Annual General Meeting of the All-India Soap Makers' Association, Mr B. Maitra, during his presidential address, referred to some serious problems facing the soap manufacturers in India and put forward some suggestions which deserve attention. The soap makers have been particularly hard hit by the present war which has made the problem of the supply of such essential raw materials as caustic soda, cocoanut oil, tallow, essential oils and aromatic chemicals extremely difficult of solution. To this has been added the shortage of labour which has assumed no less serious proportion. All these seem largely the consequence of absence of any planned policy, so far as the Government is concerned, for the development of industries. He referred to the National Planning Committee which indeed raised high hopes for the future; but these have now been frustrated owing to the continued detention of its chairman Pandit Jawaharlal Nehru. Clouded as the present situation of soap-making in India is, the post-war problems should engage the attention of all concerned while the war is still in progress. Mr Maitra has advocated the formation of a Committee of scientists to study and advise on post-war problems, of which he has himself suggested some. Some of his suggestions include the installation of plants for the manufacture of caustic lye, the collection of soap lyes from local plants for the manufacture of glycerine, the production of cocoanut oil in Madras and Bengal, the development of hydrogenated oil industry and essential oil and aromatic chemicals industry, etc. He also realised the need for research and control which should find due consideration in post-war planning for soap industry in India. He advocated the introduction of co-operative research as the only effective measure to make available the results of indispensable scientific investigation to this industry.

ONE MILLION DOLLARS FOR PROGRESS OF SCIENCE IN CHINA

We learn from a report in *Nature* that the British Council for the Promotion of Science and Technology in China has set aside a sum of one million dollars as cash awards for solution of scientific problems connected with national defence. The Council has selected ten special industrial and scientific problems in which research is to be undertaken. Chinese men of science, industrial technicians and reseach workers have been invited to undertake studies and research on these problems. They will be required to submit reports of their results to the Council before the end of the current year.

NEW FELLOWS OF THE ROYAL SOCIETY

Prof. A. V. Hill, Secretary, Royal Society, London, has informed us of the election of the following to the fellowship of the Royal Society: R. A. Bagnold, R. P. Bell, C. R. Burch, S. Chandrasekhar, G. E. R. Deacon, J. C. Drummond, A. T. Glenny, R. T. Hatton, R. D. Haworth, W. O. Kermack, F. Kidd, B. A. McSwiney, G. F. Marrian, M. Polanyi, A. Sand, W. Stanier, C. J. Stubblefield, O. W. Tiegs, H. J. Van der Bijl, J. H. C. Whitehead.

J. C. Drummond is Professor of Biochemistry at University College London and scientific adviser to the Ministry of Food. *F. Kidd* is a botanist and head of the Low Temperature Research Station of the Food Investigation Board of the D.S.I.R., at Cambridge. *B. A. McSwiney* is a physiologist and Dean of the St. Thomas' Hospital Medical School. *G. F. Marrian* is a biochemist and Professor of Medical Chemistry at Edinburgh. *M. Polanyi* is professor of physical chemistry at Manchester. *A Sand* is a zoologist and works in the physiological section of the Marine Biological Laboratory at Plymouth. *W. Stanier* is a mechanical engineer, was chief engineer to the British railways, and is now one of the three

scientific advisers to the Minister of Production. *O. W. Tiegs* is an Australian zoologist. *H. J. Van der Bijl* is a South American electrical engineer and a Foreign Member of the National Academy of Science, Washington. As to the rest, we are not properly informed. A full account of Prof. Chandrasekhar's scientific works will however be published in one of our subsequent issues.

ROYAL SOCIETY MEDALLISTS

The King of England has approved the recommendations made by the council of the Royal Society for the award of the two Royal Medals for the current year as follows:

To Sir Harold Spencer Jones, F.R.S., for his determination of the solar parallax and of other fundamental astronomical constants.

To Dr E. B. Bailey, F.R.S., for his distinguished contributions to the knowledge of mountain structure and his studies on the teconics of vulcanism.

The following awards of medals have been made by the president and council of the Royal Society:

The Copley Medal to Sir Joseph Barcroft, F.R.S., for his distinguished work on respiration and the respiratory function of the blood.

The Davy Medal to Professor Ian M. Heilbron, F.R.S., for his many notable contributions to organic chemistry, especially to the chemistry of natural products of physiological importance.

The Sylvester Medal to Professor J .E. Littlewood, F.R.S., for his mathematical discoveries and supreme insight in the analytical theory of numbers.

The Hughes Medal to Professor M.L.E. Oliphant, F.R.S., for his distinguished work in nuclear physics and mastery of methods of generating and applying high potentials.

BENEFACTORS OF SCIENCE CONGRESS

We understand that Messrs Burmah Oil Co. (India Trading), Ltd., have become Benefactors of the Indian Science Congress Association by paying the requisitive donation to the funds of the Association. This is a very happy sign of the interest which the industrial organisations of the country are begining to take in the development of science and scientific research in India. It is also a pleasure to recall in this connection that last year Messrs Tata Iron & Steel Co., Ltd., also became a Benefactor of the Science Congress Association. In fact, the firm of the Tatas, pioneer as it had been in the field of big industries, was also the first to be a Benefactor of the Indian Science Congress Association.

We may mention here for information of our readers that an institution paying a lump sum of Rs. 1,000 (or more) may become a Benefactor of the Indian Science Congress Association. Every Benefactor has the right to nominate one person as Ordinary Member of the Association.

ANNOUNCEMENT

Mr M. Rahimullah (Quraishi) of the Osmania University, now Fisheries Officer of the Hyderabad State has been awarded the degree of D.Sc. of the Madras University on the thesis entitled "A comparative study of the Morphology, Histology and Probable Functions of the Pyloric Caeca in Indian Fishes, together with a Discussion on their Homology."

SCIENCE IN INDUSTRY

VEGETABLE DYESTUFFS FOR PULP AND PAPER

THE Indian Forest Leaflet No. 44 contains an account of some important experiments on the possibilities of employing vegetable dyes for colouring paper pulp, carried out in the Chemistry and Minor Forest Products Branch, of the Forest Research Institute, Dehra Dun. The inferiority of vegetable dyes to the synthetic ones is already known. But the need for exploring the possibilities of employing vegetable dyes has been urgently felt in recent years now that war has seriously curtailed supplies of synthetic dyes from abroad. The investigations undertaken at the instance of the Indian Paper Makers' Association have indicated the suitability of five indigenous vegetable dyestuffs for colouring paper pulps from the following: (1) Tamarind seed *testa*, (2) *Kamala*, (3) Gum Kino, (4) Cutch and (5) Sanderwood.

The annual production of tamarind in India has been estimated at 3·5 million maunds yielding about 1·5 million maunds of seeds. The economic value of this vegetable product has as yet hardly been realised. The kernel of the seeds has been found by recent investigations to be the richest source of commercial pectin. It is the *testa* constituting 45 per cent of the seed, from which the dye is to be extracted. According to the estimate given, the cost per pound of the dye from tamarind *testa* works out to be Re. 1-3-9 p., which may be further reduced to about As. -/13/- a pound, pending the development of a pectin industry from tamarind kernel.

Kamala is the orange red power which exists as a grandular pubescence on the fruits of *Mallotus philippinensis*, a small evergreen tree met with throughout the tropical India. The ripe capsules are gathered and shaken in bags until the powder separates. Alternatively, the fruits are stirred in water and the sediment is collected in the form of cakes from which the dye may be extracted. Kino is the dried astringent exudate of *Pterocarpus marsupium*, a large deciduous tree of Central and South India. The manufacture of the gum from the exudate of the tree is carried out in North Malabar in the months of February and March, when the trees are in blossom. The dye extracted from Kino produces much the same shades as that from tamarind *testa*. Cutch is the colouring matter obtained from the heartwood of *Acacia catechu*. It is associated with catechin (*katha*) and in the process of extraction of *katha* by the country methods, the valuable cutch is allowed to go to waste. In factory practice, however, the cutch is fully recovered. It is a valuable dyeing material to obtain shades of brown and khaki. The dye, santalin, is obtained by extracting with alcohol rasped sanderwood (*Pterocarpus santalinus*). This is a small sized tree found chiefly in South India. The extractable matter of the wood is nearly 20 per cent and consists of santalin and deoxy-santalin. The supplies of crude dyestuff amount to about 200 tons per annum.

The leaflet contains further information regarding the methods of extraction, prices and the processes of colouring paper pulp. Specimen discs of papers showing the shades obtained with the use of different percentages of dyestuffs on the pulp are set out in the colour shade sheets appended at the end of the leaflet. It is believed that commercial quantities of the dyestuffs can be made available, should a demand for them develop in the paper industry.

A DIRECT-INTENSITY MICROPHOTOMETER

A DIRECT-INTENSITY microphotometer has been recently installed at the Observatory of the University of Michigan. The design of this microphotometer has been ingeneous in many respects and has several added advantages and uses. The instrument can be used with 'standard spot' calibrations, as a transmission microphotometer, and as an isophotometer for use on faint diffuse objects. A short description of the instrument, the full details of which have been published in the *Astrophysical Journal*, 98, 43, 1943, is reproduced here from a note in *Nature*, December 25, 1943.

"The instrument has two plate careers, on one of which is placed the photograph or spectrogram under examination, on the other, which can be moved transversely, a calibration photograph or wedge spectrum. This latter is kept in step with the other longitudinally while being moved transversely by automatic means in such a way that the densities of the two plates are always equal. This transverse motion is transferred by means of a cam and mirror to the final trace, which then reproduces directly the relative intensities in the photograph under examination. Line contours in absorption spectra can be reproduced to better than one per cent of the continuum for plate densities between 2·0 and 1·1, while the speed of operation is such that spectrophotometric comparison of two continuous spectra can be carried out at forty wave-lengths over a range of 2500A. in an hour and a half."

USKOL: THE NEW SYNTHETIC RUBBER

THIS is an age of synthetic rubber. Various types of synthetic rubber, such as Buna S, Buna N, Neoprene, Butyl, Thiokol and Paracon, most of which have been developed within the last few years, have already gone into production. According to a report of *Chemical and Engineering News*, November 25, 1943, another new synthetic rubber, called Uskol, has been developed by the General Laboratories of United States Rubber Company. Several important advantages have been claimed for this new synthetic variety. The most notable of all properties is the high degree of resistance uskol offers to solvents, such as fuels, oils, gasoline, dry-cleaning fluids and other penetrating chemicals which react on natural as well as other varieties of synthetic rubber. Accordingly, its use in the manufacture of commodities which are liable to come in contact with the above chemicals has been recommended. It may also be used for the preparation of such specialities as industrial moulded items, tubing, gas and oil hoses, tank linings, and for application to paper and card board to render them resistant to grease, water and chemicals. Rain-coats made of this new synthetic rubber can be dry cleaned. So far as resistance to the effects of sunlight, ozone and oxygen is concerned, uskol proves superior to all other varieties. In tearing resistance it also exceeds natural rubber. It may be used alone or as a blend with other synthetic varieties. It is, however, stated that the new product is not satisfactory for the manufacture of tyres in general; but in various items in the manufacture of the same, uskol may be used with advantage in place of other synthetic types now in use.

In this connection mention may be made of the synthetic rubber—Paracon, which has also been announced very recently (SCIENCE AND CULTURE, Vol. IX., No. 7). The product synthesised by Drs C. S. Fuller and B. S. Biggs, of the Bell Laboratories, is also reported to offer high resistance to heat, light and oxidation and is damaged by oil or petrol with difficulty. Plasticity of paracon also allows it to be moulded into intricate shapes and used in the preparation of rubberized fabrics.

A NEW ADHESIVE

THE same issue of the *Chemical and Engineering News* reports a new adhesive developed at the laboratory of the Svartvik Sulphite Mill (Svenska Cellulosa A/B), Sweden. The new adhesive, known as cellufix, is intended primarily for the food industry. It is not a substitute, but a chemical technical product made in Sweden for the first time. Two types of this product have been developed, namely, cellufix, a dry and white material, and cellugel, a more highly refined form with greater affinity for water.

Cellufix, it is stated, is colourless and odourless and dissolves in water at almost all temperatures. It forms a clear, homogeneous, viscous solution when mixed with a large quantity of water and, when dry, becomes a clear, transparent film resembling gelatin. Mixed with wood flour and gypsum it produces a suitable filler which can be used in preparing glue paint. It has been used in the manufacture of printing paste of considerable importance in the textile industry, which bids fair to replace gum tragacanth. In solution, cellufix serves as a satisfactory substitute for oil in some cases.

Sweden previously depended on Germany for the supply of such materials as methyl and ethyl cellulose, cellulose glycolate, and similar products. This new adhesive appears to relieve her of this disadvantage and opens up a new field of development and manufacture.

MANUFACTURE OF INDUSTRIAL PLANTS

IN the wake of the devastations of war, inventive brains and enterprising skills often find profitable outlets. To make up the shortage of supplies of materials, plants and consumer goods from other countries each country aims at self-sufficiency at least with regard to essential things. A great fillip in the Indian industrial world has been witnessed in recent times. The development has not been always in keeping with peace-time economy but the immediate needs of the country are being served. A great defect in our industrial structure has been the absence of engineering firms which can fabricate plants for manufacturing processes. Two big chemical manufactures have set to work, namely, Tata Chemicals and Metten Chemicals, and a host of small factories for light chemicals have also sprung up. We have been informed that some of the chemical plants like rotary kilns, distillation plants, filter presses and a number of special designs according to requirements of the army have been made in India and are giving satisfactory service. We were taken to a small firm near Calcutta whose achievements in the manufacturing of diverse chemical plants are quite praiseworthy and the skilful enterprise of the authorities of the Chemical Industries and Engineering Company bids fair to be of good service to our manufacturers. In Bombay and Madras side of the country a few groups of trained experts are serving the needs of local manufacturers. What is now needed is the exploitation by our big manufacturers of the resourcefulness of these engineering units who have shown also skill in designing. We would urge our industrial magnates to pay particular attention now to the making of industrial process plants in order to be ready for a solid industrial structure. The skill is evident and enterprise is not lacking. Big financial pools may utilise the opportunity for really huge undertakings instead of waiting for shipping space.

MANUFACTURE OF HIGH-DUTY CAST IRON IN INDIA

H. TRIVEDI,

JAMSHEDPUR ENGINEERING & MACHINE MANUFACTURING CO. LTD.

TATANAGAR

WITH the progress of War, there is an ever increasing demand on steel production in India. The steel manufacturing industries of this country are working to their maximum capacity. It is imperative that other materials be substituted for steel wherever practicable. In fact Grady Mission realised this point and recommended that efforts should be made to replace steel with cast iron, if possible. Unfortunately this very important recommendation of the Grady Mission has not been taken up to any considerable degree in this country. The main departments, which could have worked it out in practice, have been the Railways and the Supply Department of the Government of India. Both in America and United Kingdom this has been done to a very large extent. It is at those places that practically all the latest development in cast iron have been made. The reasons for India's backwardness may be twofold.

In the first place, people in charge of setting up of engineering and mechanical specifications in this country, have got some sort of a prejudice against cast iron. This prejudice has been born out of an improper appreciation of the great strides the manufacture of cast iron has made during the last few years. In the second place, very few people realise that all these special kinds of cast irons have already been manufactured in India and the proper technique has been mastered. The author has, himself manufactured thousands of tons of articles in special cast iron at Jamshedpur Engineering & Machine Manufacturing Co., Ltd., Tatanagar, Bihar. The aim of this short note is to give an idea of the various types of cast iron which have been made here. These special cast irons will be referred to as High-Duty Cast Irons.

There may be considered two classes of High-Duty Cast Irons: (1) those having high strength properties and (2) those having other special properties.

High Strength Irons

There have been three main reasons for the low-strengths of ordinary cast iron: (1) the large graphite flakes constituting planes of weakness which tend to join up into lines on the micrograph thus extending their weakening effect, (2) the hard brittle phosphide eutectic, which constitutes a source of weakness, and (3) the Duplex structure of ferrite and pearlite.

The removal of these defects from cast iron has been accompanied by greater technical control in the foundry and by the adoption of certain manufacturing techniques. Foundry control in its simplest form can reduce the weakening effect of phosphide eutectic by selecting raw materials of lower phosphorus content. Technical control of a higher order is needed to reduce the inherent disadvantage of the Duplex structure and to achieve an all-pearlitic structure. This is achieved by balancing the composition so that it will give an all-pearlitic iron in the section to be cast.

To make a high-duty cast iron, both the matrix and the quantity and character of graphite have to be kept under control. The matrix in most of high-duty cast irons is kept fully pearlitic, but in certain application even higher strength can be obtained by making the matrix acicular or pseudo-martenitic. All of these desired structures are brought almost by adopting a proper composition of the iron and with the help of alloys and by resorting to heat-treatment.

The quantity of graphite and its character is controlled by adjusting the total carbon content of the metal and by treating the metal in different manners.

As a result of the above mentioned processes, cast irons have been produced with a fair degree of strength. Table I on the next page is a summary of B.S.S. 786-1938, which gives the various mechanical properties for four grades of cast iron. A range of standard bars is used with the object of matching the bar size with the section of the casting it represents.

It is difficult to obtain cast irons with a tensile strength much over 25 to 28 tons per sq. in. in the ascast condition when pearlitic structures only are employed. With the help of alloys and heat treatment acicular irons are produced. For such an iron the tensile strength for a bar of 1½" section was found to be about 40 tons per sq. in.

All the above mentioned high-strength cast irons, have been manufactured at the author's firm for some time on a commercial scale. The maximum weight *for a single casting* which we have made up till now has been about 20 tons and it is the maximum we can do up-to-date. We have got Reverberatory and hearth furnaces, which enable us to control carbon, phosphorus and sulphur simultaneously and individually. The maximum tonnage of high-strength cast iron, which we have manufactured, has been for rolls for rolling steel for all the Steel Rolling Mills of India. We have made in addition heavy-duty lathes, boring machines, boring bars, slotting machines,

hammer-blocks etc., out of high strength cast iron. It has been found in practice that with the use of high-duty cast iron spindles and gears, it is possible to operate lathes, milling machines etc., at a much higher speed utilizing the remarkable properties of tungsten carbide cutting tools to their fullest advantage on account of the vibration absorption properties of grey iron. Apart from its tensile properties, this iron, has excellent machinability, taking a beautiful finish even when extended to fine screw cutting on heavy sections. All high-duty irons lend themselves very readily for nearly all heat-treatment processes, an instance being the heat-treatment of high-duty grey iron gear-teeth. Pumps and compressor bodies originally made from cast steel are now made in high-duty cast iron. The material obtained is perfectly sound and can stand up to a pressure of even 1000 lbs. per sq. in.

TABLE I

SUMMARY OF TESTING REQUIREMENTS IN BRITISH STANDARD SPECIFICATION NO. 786-1938 FOR HIGH-DUTY IRON CASTING GRADES 1, 2, 3 AND 4.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		TRANSVERSE TEST												TENSILE TEST				
		Grade 1			Grade 2			Grade 3			Grade 4				Min. ultimate Tensile Stress			
Standard Dia. of Test Bar	Distance between supports	Min. Breaking load on Standard Dia.	Corresponding Transverse Rupture Stress	Min. Deflection	Min. Breaking load on Standard Dia	Corresponding Transverse Rupture Stress	Min. Deflection	Min. Breaking load on Standard Dia.	Corresponding Transverse Rupture Stress	Min. Deflection	Min. Breaking load on Standard Dia.	Corresponding Transverse Rupture Stress	Min. Deflection	Gauge dia. of test piece	Grade 1	Grade 2	Grade 3	Grade 4
in.	in.	lb.	Tons per sq. in.	in.	lb.	Tons per sq. in.	in.	lb.	Tons per sq. in.	in.	lb.	Tons per sq. in.	in.	in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.
0·6	9	570	27	0·07	635	30	0·08	715	34	0·09	865	41	0·10	0·399	16	19	23	26
0·875	12	1270	25·9	0·11	1420	28·9	0·12	1620	33·0	0·13	1910	39	0·14	0·564	15	18	22	25
1·2	18	2120	25·0	0·16	2370	28·0	0·17	2630	31·0	0·18	3130	37	0·23	0·798	14	17	20	23
1·6	18	4800	24·0	0·13	5400	27·0	0·14	6000	30·0	0·16	7010	35	0·18	1·128	13	16	19	22
2·1	24	8000	23·6	0·17	8850	26·1	0·19	9850	29·1	0·21	11200	33	0·24	1·596	12·5	15	18	21

SPECIAL IRONS

This group consists of:

(1) Corrosion resisting irons *e.g.*, austenitic and 13-18 per cent silicon irons; (2) Heat resisting irons and (3) Abrasion resisting irons *e.g.*, ordinary chilled cast irons and martensitic irons.

Corrosion Resisting Irons:—Austenitic irons are the most important of this class. In the cooling of cast iron from the liquid state, the material is deposited as austenite and normally changes at the critical point to pearlite which may be mixed with ferrite or carbide. The addition of certain alloys is capable, however, of suppressing this critical change so that the material is austenitic when cold. Such an iron is essentially stainless, showing a marked degree of resistance to corrosion and the effects of heat. It possesses medium tensile strength of 13-17 tons per sq. in., has increased ductility and higher impact value compared with normal grey iron. The hardness is of the order of 140 to 160 Brinnel or higher. It is non-magnetic, has higher electrical resistance, higher thermal expansion and lower thermal conductivity than ordinary grey iron. Table II shows the results of corrosion tests carried out on an austenitic cast iron, on an ordinary cast iron and on phospher bronze. It will be seen that the resistance of austenitic cast iron is in many corrosive media commensurate with and in some actually superior to that of phospher bronze, whilst in nearly every case it is many times that of ordinary cast iron.

The work hardening properties of the austenitic cast irons also render them extremely resistant to abrasion and erosion. This resistance to combined corrosion and erosion is of especial value in pumping machinery or chemical plant which involve the

TABLE II

Corrosive Medium	Austenitic Cast iron	Cast iron	Phospher Bronze
Acetic Acid 33%	17·0	840	18·6
Boracic Acid 10%	7·7	57·4	4·6
Citric Acid 5%	9·3	1492	4·6
Formic Acid	13·9	138	13·9
Hydrochloric Acid 1% ..	32·5	1007	41·8
" " 5% ..	54·2	3360	57·3
" " 20% ..	62·0	11180	60·5
Nitric Acid 1%	620	697	2446
" " 5%	4060	4680	12420
" " 20%	7830	10092	Dissolved
Oxalic Acid 5%	6·2	55·8	12·4
Phosphoric Acid 50% ..	26·4	4650	7·7
Sulphuric Acid 1%	26·4	1642	18·6
" " 5%	37·2	6880	37·2
" " 20%	41·8	13720	38·8
Sulphurous Acid	240	1032	9·3
Tartaric Acid 5%	10·8	1040	10·8
Vinegar	4·6	104	4·6
Acetone	1·5	4·6	1·5
Aluminium Sulphate 5% ..	20·0	96·0	10·8
Ammonium Chloride 5% ..	10·8	35·6	57·4
" Nitrate 5% ..	51·2	163	57·4
" Sulphate 10% ..	9·3	32·6	13·9
" Sulphate+5% Sulphuric Acid ..	26·3	11160	21·7
Carbon Tatrachloride ..	1394	8030	543
Ferric Chloride 5%	667	1038	347
Fuel Oil	1·5	1·5	1·5
Hydrogen-peroxide 20-V ..	6·2	9·3	1·5
Magnesium Chloride 10% ..	7·7	18·6	6·2
" Sulphate 10% ..	3·1	14·0	3·1
Potassium Alum 10% ..	15·5	372	20·2
Sea Water	6·2	23·2	6·2
Sodium Chloride 3%	7·7	12·4	3·1
" Hypochlorite ..	223	688	80·6
" Sulphate 5% ..	9·3	7·7	9·3
" Sulphite 10% ..	3·1	6·2	1·5
" Sulphide 5% ..	1·5	1·5	17·0

N.B.: Figures represent the loss in mgms. per sq. decimeter per day under static conditions at 30°C.

handling of water containing sand or other solids in suspension.

As already stated above the austenitic cast irons show marked superiority to ordinary cast irons when exposed to elevated temperatures and particularly to conditions of heating and cooling such as would be conducive to growth in ordinary cast iron. The incidence of growth is chiefly to be attributed to the expansion and contraction which occur at the critical temperature (750°C) in ordinary cast iron. Since austenitic cast irons do not undergo any change of state or volume at such temperatures they are practically immune from growth. As heat resisting materials, austenitic cast irons are finding many applications, particularly in the chemical industry and in furnace construction.

In addition to the austenitic irons, cast irons with silicon content of the order of 13 to 18 per cent have extremely good acid resisting properties. They are, however, very brittle, unmachinable, except by grinding and are rather difficult to manufacture. The author has made both the above named corrosion resisting irons at JEMCO.

Heat Resisting Irons.—In addition to austenitic irons there are other types of cast irons, which have considerable heat resistance. They are (1) High-silicon irons, (2) High-chromium irons and (3) High-aluminium irons.

Irons with the silicon contents of the order of 5 per cent to 6 per cent have a good amount of heat resistance. The silicon raises the critical point, thus increasing the range of temperatures which may safely be used and the silico-ferrite has considerable resistance to scaling. They can be used at temperatures upto 900°C with good resistance to scaling and growth. They are, however, extremely brittle. The austenitic irons are much better in this respect and may be used upto temperatures approaching their melting point.

Irons containing fairly high percentages of chromium have been developed in recent years. They have very good heat resisting and also corrosion resisting properties. Their structure consists of chromo-ferrous ferrite containing chromium carbide. Their mechanical properties vary considerably with their total carbon content, with rather high carbon they are extremely difficult to machine and rather brittle, but with lower carbon content they become better from these points of view, though more difficult to cast. The author has made a few needle-heat exchange elements in some types of chromium cast iron with fair results.

An Aluminium-Chromium cast iron (patented in England under the name of "Cralfer") embodies the excellent scale and growth resisting properties of the high silicon irons without the brittleness which accompanies that type of material. It is certainly somewhat more brittle than grey cast iron in the cold, though the impact value is good, but it is remarkably strong at elevated temperatures. As it was a proprietory material, we have not made it, as yet, at JEMCO.

Abrasion Resisting Irons.—Abrasion resisting castings are a speciality of this foundry. Ours is the only foundary in Asia, excepting Japan but including Soviet Russia which makes Chilled Cast Iron its speciality.

The properties of white or chilled cast irons, which make them valuable for engineering purposes, are high hardness coupled with high compressive strength, resulting in a combination which is very resistant to wear under high intensities of pressure. The application of chilled iron is very diversified. Resistance to wear and deformation under high intensities of pressure are its outstanding properties. The compressive strength of unalloyed chilled iron is in excess of 200,000 lbs. per sq. in. and the hardness over 60 scloroscope. The largest tonnage of any

single item manufactured from chilled iron is railroad car wheels; over 2,000,000 wheels have been produced only in the U. S. A. annually for the past ten years., representing a yearly tonnage of approximately 750,000 tons. The next largest single item is in all probability chilled iron rolls for rough and finished rolling of metals and for crushing grain and ore. In addition to these a long list of items such as farm implements, heavy-duty castings for coal crushing, grinding mill liners, grinding balls, cement grinding machinery, jaw crusher plates, stamp-mill parts etc., are quite generally made of chilled iron. Frequently wearing plates in chutes handling abrasive materials and liners in sludge pumps are likewise made of chilled iron.

In this country as in United Kingdom, chilled car wheels have not been given the treatment they deserve. British specifications are lukeworm towards them and so have been the Indian specifications. As a result we find very few chilled cast iron wheels on the Indian Railway. In the States and Canada, "Chilled Car Wheels Industry" is a major one. In those two countries alone, there are 16,000,000 chilled wheels in service, weighing some 5½ million tons.

The technical advantages of chilled iron wheels are (1) they have an exceptionally high co-efficient of friction between the wheel and the brake-shoe; (2) the life of the brake-shoe on chilled iron tread is an extremely prolonged one, as compared with the results obtained when operating on other metals; (3) the abrasion between the flange of such wheel and the steel rail is less than between the steel and steel. This brings about an appreciable reduction in both trains resistance and the wear of the rail and the flange; (4) the bearing value is unexcelled, hence the heaviest load can be carried without the least indication of cold rolling or flowing of metal at the surface of the treat and (5) rotundity is retained on account of absence of ductility.

The average life of a chilled wheel may be taken at approximately 600,000 ton miles. There is considerable economy in using chilled car wheels as against steel wheels. Chilled wheels are cheaper because, the material is cheaper, there is less capital investment in wheel and shop machinery and a complete elimination of machining except for the central hole in the soft iron of the hub, and there is low first cost on account of the exchange factor by which the worn out wheels are exchanged for an equal tonnage of new wheels. The factor of safety against train derailment is as great, if not greater, as in other types of wheels under similar operating conditions. Half-a-century of strenuous service in U. S. A. has placed the chilled wheels on a very secure foundation and there is now a guarantee for uniform service with car wheels.

We have recently started the manufacture of chilled car wheels and so far as their physical properties are concerned, we got excellent results. The demands for those wheels are at present extremely meagre. It is however, believed that as the Railway Engineers know more about the capacity and the capability of chilled wheel and about their manufacture in India, demand for them will grow and their cost consequently brought down.

The manufacture of chilled iron rolls is an extremely difficult and specialised operation. In fact it is the most difficult manufacture which any foundry may do. We are specialising in this most difficult manufacture. We are manufacturing rolls for all the rolling mills of India, whether they be rolling steel, brass, copper, aluminium, zinc or bullion. We make rolls to meet every character of service, rolling both hard and soft metals into any kind of section, rolls for the rubber factory, calender rolls for the paper and textile mills, grain crushing rolls and rolls for the sugar mills.

The above rolls are made either in pearlitic grey iron or pearlitic white iron. It is not possible in these irons to secure a chill surface hardness much greater than above 500 Brinnel. With the addition of special alloys in well balanced proportions, a hardness of over 750 Brinnel is obtained on the chilled surface with an equivalent core-strength from 20 to 100 per cent greater than that of the plain carbon iron.

Plain chilled iron consists of a sponge-like framework composed of iron carbide or cementite filled with a matrix of pearlite. The pearlitic matrix occupies more than one-half of the volume of the chilled zone and the effect of the increasing amount of alloys (balanced with respect to the composition of the base iron and section of the casting) in moving this matrix into the sorbitic, troostitic and martensitic conditions, is believed to be largely responsible for the increased hardness of the chilled surfaces. We make the above kind of alloy rolls for such conditions of service as demand—super fine finish on the rolled material *e.g.* wire industry and hoop industry. The fully hardened alloyed chilled iron possesses a marked resistance to corrosion compared to plain iron, thus adding service life to casting which frequently suffer as much from corrosion as from wear, particularly in mines and chemical operations.

We have the technical experience and equipment for making cast irons of the above categories; we are further prepared to consider any enquiry regarding the manufacture of articles in cast iron (or non-ferrous metals) of any particular specification. It has been our privilege to do service of no mean character in connection with our victory and we hope and trust that our contribution towards the post-war national reconstruction will be equally great if not still greater.

MEDICINE AND PUBLIC HEALTH

PREVENTION OF COLDS

A NEW sulpha drug that brings prompt relief in colds and seems to shorten their duration, and the prevention of ear and sinus infections after a cold by a different sulpha drug used as a nose and throat spray are reported in a recent issue of *Science News Letter*.

The new sulpha drug is desoxyephedronium sulphathiazole and is made by combining sodium sulphathiazole with an ephedrine compound of the type used to shrink the swoollen nasal membranes during a cold. It is announced by Dr Frederick Myles Turnbull, Dr William F. Hamilton, Eli Simon and Melvin F. George, Jr., of the Lockheed Aircraft Corporation Research Laboratory at Burbank, Calif.

The prevention of ear infection, sinusitis, sore throat, laryngitis and coughs following colds by the sulphadiazine spray originally developed to fight infection in severe burns is reported by Dr David A. Dolowitz, Dr Walter E. Loch, Dr Henry L. Haines, Dr Arthur T. Ward, Jr., and Dr Kenneth L. Pickrell, from the Johns Hopkins Hospital, Baltimore.

The number of nose and throat complications of the common cold are steadily decreasing, the Hopkins doctors point out because so many doctors and child specialists are giving sulpha drug pills for every acute infection of the nose and throat.

One objection to giving large doses of sulphadrugs by mouth for an infection in one part of the body is that almost a third of the patients develop nausea, dizziness, fever, skin rash or more serious trouble as a result of the drug. They believe it better to apply the sulpha drug directly to the infected nose and throat, just as sulpha drugs are applied directly on wounds and burns to fight infections of them.

Twenty-four-hour recoveries of patients with red, swollen throats and constitutional symptoms followed the use of the sulphadiazine spray in many cases when the sore throat was due to beta hemolytic streptococcus infection following a cold, the Hopkins doctors report.

Other streptococcus germs and pneumonia germs do not disappear so quickly from the throat, but apparently lose their virulence or ability to become virulent, judging from the clinical symptoms. It is these streptococcus and pneumonia germs and other bacteria which prolong a cold and cause lost time from work and the more serious complications.

In a group of nurses who were given the spray as soon as they reported to the infirmary with a cold, only 9·7 per cent developed sinusitis, compared with 30 per cent in a control group not given the sulpha spray. The sprayed group developed coughs in 8 per cent and ear trouble in 1·8 per cent but no laryngitis and no sore throats. In the control group, 44 per cent developed coughs, 10 per cent sore throat, 2·3 per cent laryngitis and 4·5 per cent ear trouble.

The nose and throat spraying was done eight to twelve times a day for three days, and five to eight times a day for two or three days more.

The new sulpha drug announced by the Lockheed scientists was used on cotton as a nasal pack and also as nose drops and spray. Combining the ephedrine compound with the sulpha drug reinforces the effect of the ephedrine in shrinking the swollen nasal membranes. The sulpha drug gets farther into the nose and sinuses, and less of the ephedrine need be used. This has the advantage of avoiding the sneezing, sleeplessness, nervousness and heart palpitation which sometimes follow the use of ephedrine alone in nose drops.

More than 1,000 cases of nose, throat and ear infections have been treated with the new drug. In acute colds, it "resulted in rather prompt relief and the duration of the infection was apparently shortened. This was also true in acute sinusitis with less tendency to become subacute or chronic", the Lockheed scientists report.

Many patients with chronic sinusitis were helped who otherwise would have had to have an operation. Acute ear trouble was a much less frequent complication.

THIAMIN SYNTHESIS IN MAN

ACCORDING to a report of *Science News Letter*, Dr Victor A. Najjar and Dr L. Emmett Holt, Jr., of the John Hopkins University Department of Pediatrics, have produced the first direct evidence for the biosynthesis of thiamin in man.

For seven weeks four young men lived without sign of vitamin hunger disease on a diet completely lacking in thiamin. They were not getting the vitamin in pills or from any other outside source and they had been on low thiamin rations so long that little or none could have remained stored in

their bodies from previous supplies. A similar group of four young men on the same diet regimen did develop signs of thiamin deficiency, such as neuritis, swellings, loss of appetite and vomiting.

Tests of the four who stayed healthy without any outside supply of the vitamin showed that they were excreting large amounts of free thiamin in their intestinal wastes. Further tests convinced the Hopkins scientists that these four thiamin-starved young men were getting enough thiamin to stay healthy from bacteria in their intestines. Intestinal bacteria have been known to produce thiamin for rats and ruminants, but so far the question of whether man's intestinal bacteria could supply him with thiamin has been largely unanswered. Whether the intestinal bacteria could supply enough thiamin to keep a man healthy for an indefinite length of time has not yet been determined.

Diet rules regarding thiamin requirements seem likely to be revised in the future as a result of these findings. A number of contradictory points may be explained, such as why beriberi from lack of thiamin develops much more frequently among rice eaters than among those who live largely on their milled grains.

Sulpha drug treatment also is likely to be revised somewhat as a result of the discovery of the Hopkins scientists. Part of their search for the thiamin supply that was keeping the young volunteers healthy on a thiamin-starvation diet consisted in giving them doses of succinyl-sulphathiazole every four hours for one week.

At the end of the week, there was no more free thiamin in the intestinal wastes, evidence that the thiamin-producing bacteria were being destroyed or put out of production by the sulpha drug. This suggests that in the future when doctors give a sulpha drug for intestinal infection, such as dysentery, they will be giving thiamin pills to make up for the production loss in the body's factory.

POST-WAR HEALTH PROBLEMS IN INDIA*

We are living through stirring times and the medical profession is, in keeping with its tradition, playing a full and not inconspicuous part in the great adventure in which the Allied nations are engaged. It is indeed difficult to keep one's thoughts in any other channels than those which are connected with the prosecution of the war and attainment of that complete and unconditional victory which, thank God, it is now possible to say is approaching the horizon, and of which, like that of the rising sun, the foreglow is now clearly discernible and is the object of countless longing and speculative glances. After night comes day; and after war comes peace which "hath her victories no less renowned than war". It is towards winning of these victories that the attention of thoughtful persons among the United Nations, from their leaders down to the sailors, soldiers and airmen in the ranks, is being directed in an ever-increasing degree; and never before has so large a proportion of humanity been so unanimously resolved that there shall be no return to the bad old pre-war systems, but that out of these years of struggle, effort and sacrifice shall emerge a better order of living for humanity as a whole and especially for the common man and the common woman.

This urge to develop is no news in India. The speeches of our leaders, the press and the radio have seen to that. Recently in two broadcasts from Calcutta and from Delhi Professor A. V. Hill, Secretary of the Royal Society has made a very strong plea for Indian development and the organisation needed for the purpose. Professor Hill has placed the expansion of health in the very fore-front of his programme.

Basic Requirements

Throughout the civilised world there is now complete agreement that health is a basic human right. The human being is not consulted before entering this world, and should not, in equity, be exposed to preventible handicaps. It is therefore a primary duty of every sovereign State to ensure that its citizens have at their disposal all the necessary ingredients of positive health. What are these ingredients? They are:—

To every citizen:

(1) ordinarily,

   (a) an ample and pure water-supply,
   (b) foodstuffs of necessary purity,
   (c) sanitary conservancy adapted to local needs,

* Adapted from an address delivered by Major-General J. B. Hance, C.I.E., O.B.E., K.H.S., I.M.S., Director-General, Indian Medical Service, at the Founder's Day celebrations of the Lady Hardinge Medical College, New Delhi, on 17th March, 1944.

(*d*) hygienic housing conditions, and

(*e*) adequate protection from preventible disease ; and

(2) when sick,

(*a*) the necessary diagnostic, therapeutic and nursing care that his condition requires, should he desire to avail himself of it.

To every woman:

(*a*) adequate care and advice when pregnant,

(*b*) adequate obstetric assistance during labour with facilities for full institutional care (diagnostic, therapeutic and nursing) for such cases as require it, and

(*c*) adequate qualified care of mother and infant during the lying-in-period.

DIFFERENT ELEMENTS IN THE SCHEME

In designing a project, the experience of similar organisations elsewhere provide one, and probably the most reliable, index of its needs. The figures quoted (Table I) are based upon Western countries, and may not be an accurate estimate of India's needs. These can only finally be estimated by India herself in the light of experience. But the present figures do form an indication of the size of the task.

Let us now, subject to that proviso, first consider the different elements in the scheme.

Doctors.—It is estimated that positive health cannot be assured to a nation unless and until they have a minimum of 1 doctor to every 1,500 of population. In the United Kingdom there is 1 doctor to every 1000 of population – in India we have 1 to every

TABLE I

REQUIREMENTS IN PERSONNEL TO BRING INDIA INTO LINE WITH MODERN TRENDS

Personnel	*Available now*	*Proportion to population* and *to area*		*Required*	*Basis*
Doctors	40,000	1 to 10,000 (U. K. 1 to 1,000)	1 to 40 sq. m.	300,000	on basis of 1 to 1500
Nurses	7,000	1 to 56,000 (U. K. 1 to 300)	1 to 226 sq. m.	778,000	on basis of 1 to 500
Health Visitors	1,000	1 to 350,000	1 to 1,582 sq. m.	70,000	on basis of 1 to 5000
Midwives	5,000	1 to 70,000	1 to 316 sq. m.	90,000	on basis of 1 to 4000 (or per 100 births)
Qualified Pharmacists ...	75	1 to 4,000,000 (U. K. 1 to 1,300, U. S. A. 1 to 1,100)	1 to 20,000 sq. m.	100,000	on basis of doctor to pharmacist—3 to 1 as in U. K.
Qualified Dentists ...	1,000	1 to 350,000 (U. K. 1 to 2,700, U. S. A. 1 to 2,200)	1 to 1,582 sq. m.	120,000	on basis of 1 to 3000

N.B.: The above figures are approximations and not exact estimates.

To every child:

(*a*) continuous medical observation (and, where necessary, treatment) during—(*i*) infancy, (*ii*) toddlerhood, and (*iii*) school life.

To provide the India of the future with these ingredients is therefore our goal, and the task to which we should set ourselves.

As to the magnitude of the task, it should be remembered that positive health can only be secured by constant, unremitting and coordinated human endeavour. The agents of this struggle are doctors, nurses, health-visitors, midwives, pharmacists and dentists, to mention only a few.

10,000. There are 40,000 medical practitioners registered in India to-day. To assure positive health to this sub-continent 300,000 are required.

Nurses.—Turning now to nurses, the minimum provision necessary to ensure positive health is 1 nurse to every 500 of population. In the United Kingdom there is 1 trained nurse to every 300 of population—in India we have 1 to every 56,000. There are 7,000 trained nurses registered in this country and to ensure positive health to the people 7,78,000 trained nurses are needed.

Health Visitors.—It is estimated that one health visitor is required for every 5,000 of population. In India today there is 1 health visitor to every 350,000.

There are approximately 1,000 trained health visitors in the country and 70,000 are required.

Midwives.—It is considered that to ensure positive health there should be one trained midwife per 4,000 of population, which works out at 1 trained midwife per 100 births. In India there is one trained midwife per 70,000 of population. There are approximately 5,000 trained midwives in the country and 90,000 are required.

Pharmacists.—It is reckoned that for efficient health services 1 pharmacist for every 3 doctors is required. In the U. K. there is 1 to every 1,300 of population and in the U. S. A. 1 to every 1,100. In India there is 1 trained pharmacist to every 4,000,000 of population. 100,000 such pharmacists are required and there are in India 75.

Dentists.—For every 3,000 of population there should be one qualified dental surgeon. In the U. K. the proportion is 1 to 2,700 and in U. S. A. 1 to 2,200. In India it is 1 to 350,000. There are in the country approximately 1,000 qualified dental surgeons and 120,000 are required.

Criticism of the Scheme

This then is the task which lies before India in her post-war development in matters of health. It is only a part of the effort which she must make if she is to keep abreast of the progress and development of the world in general and the United Nations in particular. Lest it should be thought that the goal is Utopian and the task of achieving it in any measurable period of time impossible, it may be pointed out that a very similar measure of progress in health provision *has*, in fact, been achieved in Russia in the space of 20 years, starting from conditions which were in all essentials similar to those obtaining in India to-day but without comparable advantages of communications such as this country possesses.

There are those who say that progress of this kind has only been possible by the practical application of the Marxian political philosophy. Such is not the case. Russia and the Marxian philosophy came to the parting of ways quite early in the execution of the industrial plans. The driving force behind the progress in Russia is not any political philosophy but the united and indomitable will of a whole people to place their country on the map of modern civilised progress.

It may also be argued that such progress could not have been achieved without drastic restrictions on the liberty of the subject. This may, in part, be true ; but the "greatest good of the greatest number" is as much a democratic principle as is the "liberty of the subject", and that what is required is not a clash between these two principles but their synthesis.

Other sceptics will say that the goal envisaged is admirable, but where is the money to come from? We have the authority of men like Professor Keynes and Professor Hill that money is "the servant and not the master of policy". Moreover, we have had for the past 4 years an irrefutable demonstration of this principle which has cost us dear in blood and sweat and toil and tears. Calculated in terms of money and in comparison with the wealth of the Western democracies, the resources of Germany were almost negligible, yet this has not prevented her placing in the field and maintaining for 4½ years the most highly organised, formidable and destructive fighting force the world has ever seen. If money had governed the prosecution of war this conflict would have ceased long ago ; but the driving force behind the prosecution of war is human energy and human productivity, of which money is only one convenient symbol. Exactly the same driving force has been behind the Russian progress in matters of health, and must be the motive power behind similar progress in this country and in the post-war world as a whole. Unless humanity devotes the same creative energy and ingenuity to problems of construction that it has hitherto shown in destructive activities, nothing lies before the human species but a gradual process of mutual and highly organised scientific destruction.

Part of Medical Woman

Let us now consider for a moment the share of the medical woman in the task.

Judging from the views I have heard expressed at interviews by young medical women who are candidates for admission to the various medical services, it is the ambition of the majority to devote themselves to the actual relief of disease among women and children. Such an ambition is natural enough for there is, God knows, enough dumb misery and suffering among the women of India fully to occupy the energies and devotion of every medical woman in this country for many years to come. It is also an ambition with which I personally have very great sympathy, for gynaecology was my own first love ; and in spite of the fact that force of circumstances had turned me into a "jack of all trades" with a bias to surgery, I justified the French proverb by as many and deliberate returns to gynaecology as circumstances permitted. Nevertheless I venture to doubt whether this admirable and comprehensible ambition of the majority of women doctors is the only, or indeed the best, contribution that they can make to the task we have considered.

The scriptures tell us that "There is more joy in heaven over one sinner that repenteth than over ninety and nine righteous persons that need no repentance." The medical profession, I think, have

this at least in common with the Saints in heaven there is apt to be more satisfaction over one critical case, adequately treated, than over ninety and nine healthy human beings who stand in no need of treatment. While the attitude of the Saints in heaven towards the human soul may be, and probably is, morally excellent, I venture to suggest that the application of this outlook to the human body by our profession, though comprehensible, is medically very exceptionable. We have seen that positive health is only to be secured by constant, unremitting and co-ordinated human endeavour and from this aspect the positive health of the ninety and nine should give us 99 times the satisfaction that we derive from the one successful case. At the risk of being platitudinous, I would remind you of the proverb that "prevention is better than cure". It is also very much cheaper.

A skilfully conducted abnormal labour which preserves both mother and child, or a difficult colpoperineorrhaphy is a most satisfying achievement; but surely the decline in abnormal labours due to efficient ante-natal work and the decrease in repair operations due to the proper superintendence of labour and the puerperium is vastly more satisfactory from the point of view of the community, if less clinically interesting to the individual doctor.

One would therefore plead with both teachers and students to give to the preventive aspect of their work the predominant importance that is its due. This must be our constant preoccupation if our goal is to be reached within any measurable period of time. It is, moreover, possible without the slightest diminution of that practical clinical sympathy and interest which is the distinguishing mark of our profession.

The field open to the medical women for service to the community in general and to women and children in particular, is both vast in scope and pathetically inadequate in provision. Although when one looks back at the expansion which has taken place since the first medical women came to India from the United States in 1869 the retrospect is one of great and honourable achievement, medical women will be the first to concede that little more than the surface of the problem has been scratched. The following, among others, are the channels open to medical women in this country:—

(1) The All-India and Provincial Women's Medical Services.

(2) Appointments in hospitals, general and special.

(3) Private practice—urban and rural.

(4) The military medical services.

(5) Public Health work and Social Medicine.

(6) Teaching institutions—medical education, both under-graduate and post-graduate.

(7) Industrial medicine—the care of the health of women in industry.

(8) Administrative posts.

(9) Medical Research.

Fields of Activity

Let me direct your attention briefly to only some of them taken at random:—

The field of Public Health.—The fight against tuberculosis is as yet almost entirely in male hands, yet at least half the sufferers from this disease are women. Moreover, social customs which apply particularly to women form one of the most potent factors in the spread of infection. Tuberculosis, again, is a disease in which the success of preventive work far exceeds anything that has been found possible on the curative side. Improvement in housing conditions and the examination and protection of contacts have done more to diminish the mortality from tuberculosis than all the medical and surgical skill which has been directed to the treatment of the disease when contracted.

It has been estimated that there should be one tuberculosis clinic for every 50,000 of population, *i.e.*, 8,000 tuberculosis clinics in this country. This postulates 8,000 medical women engaged predominantly on the prevention of this disease.

Half a million beds are required for the treatment of tuberculosis sufferers in India. Of this a quarter of a million will be women, and assuming that 1 medical woman can give efficient supervision to 100 patients 2,500 medical women are required for the efficient treatment of the disease when contracted.

Tuberculosis work alone, therefore, calls for 10,500 medical women to be produced during the next, say, 50 years.

It is estimated that there are in India to-day two to two and a half million blind persons. It is not unreasonable to assume that half of this number are women and it is incontestibly true that the majority of the conditions leading to blindness are contracted during childhood in the home. Yet the prevention and treatment of eye diseases in this country is, so far, almost entirely a male preserve. There is, therefore, a vast field open to the woman ophthalmologist.

Tuberculosis and blindness are both conditions which may be said to be contracted in the home. Moreover, it is the women and children who have to live in the home; yet how many housing improvement schemes have associated with them a medical woman?

Industrial Medicine.—There is high authority for the belief that India stands on the threshold of a vast industrial expansion. Women are even now extensively employed in industry, and the scale of their employment must of necessity greatly increase in the near future, carrying with it the need for a large increase in the pitifully inadequate provision for industrial medicine generally and for the care of women in industry in particular.

Social Medicine. -It is a new name for an old need. In too many cases is the patient in hospital regarded as a problem in symptoms and physical signs the solution of which involves the use of a drug or the knife, and a shorter or longer period of recovery ; and the ultimate discharge from hospital is regarded as the end of that particular problem. Too often it is the end of only one instalment of a tragic serial. The true solution of the problem demands a knowledge of the environment from which the patient came and that to which he or she will return ; and treatment can only be considered adequate when, in addition to the control of the immediate clinical condition, environmental circumstances which tend towards its repetition, or substitution by another clinical problem, have been similarly controlled. It may be said that this is the work of the Almoner. It is true that it constitutes the life work of that important part of any medical institution ; but it is predominantly the care and responsibility of the medical man or woman in charge of the individual case. Realisation of this fact has led to the establishment of a Chair of Social Medicine at Oxford University, the occupant of which is no less a personage than the late Regius Professor of Medicine at Cambridge. Realisation is also likely to be reflected in the training of the medical student who will be connected not only with the care of his patient while in hospital, but with the follow-up, in company with the Almoner, of that patient's progress after discharge. For many years to come, in the north of India at any rate, social medicine as applied to women and children, must inevitably fall into the sphere of medical women.

The need for great development in India of medical research and especially of clinical research is generally admitted. Not only in the special sphere of women and children, but throughout the vast research field golden opportunities of making real contributions to medical knowledge await the medical women : Nutrition, haematology, immunology, malaria, filariasis are only some of the aspects holding special interest for workers among women, while the subject of pediatrics abounds in unsolved problems of the child.

The primary and most clamant need of the future is more teachers. Teachers to train clinicians, public health workers and research workers. Teachers who, themselves eminent scientists and practitioners, shall be in whole-time and adequately remunerated employment, so that they may be free to give their entire attention to the teaching of the subjects entrusted to them, untrammelled by the necessity of extra financial provision for their present and future. Perhaps it is not Utopian to look forward to the establishment in this capital city of India, perhaps in this institution itself, of an "Indian Johns Hopkins" designed primarily for the training of the teachers and research workers of the future, and accepting as candidates for entry only the cream of graduates in other sciences. If some such project could be achieved, the enormous task of providing India with the instructors necessary to turn out the doctors of the future in the quantities needed, while it could not be called fulfilled could at least be faced without despair.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

CARBONISATION ASSAY OF BLENDED INDIAN COALS*

ASSAM coal has been found to possess high caking property and has a low ash content. As such this coal has been blended with a low grade non-caking coal of high ash content and carbonised at 700°C. The 1/1 blend yielded a strong coke. The Assam coal has the drawback in possessing a high percentage of sulphur. This blending with a low sulphur coal has the additional advantage of lowering the sulphur content of the resultant coke. A few data are given below:

Specimen No.	Proximate analysis data, moisture free basis			Results of carbonisation of 1:1 blend at 700°C.					
	% of V.M.	% of fixed carbon	% of Ash	% of higher olefines	% of CO_2+H_2S	% of tar	% of liquor	% of coke	% of total volatiles
F	44·43	54 45	1·12	0·56	2·67	7·88	9·56	66·75	35·25
C	29·56	61·92	8·52						

Percentage of Sulphur

Coal Specimen F.	Coal Specimen C.	Coke at 700°C. from F.	Coke at 700°C. from C.	Coke at 700°C. from 1:1 blend
4·18	0·34	1·99	0·29	1·22

K. M. CHAKRAVARTY
AMARENDRA NATH BASU

Department of Chemistry,
Dacca University,
Dacca, 10-12-1943.

ANALYSIS OF SOME INDIAN COALS AND A STUDY OF THEIR THERMAL DECOMPOSITION UNDER VACUUM. Part I*

PROXIMATE and Ultimate Analysis of the following specimens of coal has been carried out. (1) Specimen (A) from Handidhua, Talchir Coal Field, (2) Specimen (B) from Karer Kho, Korea State, (3) Specimen (C) from Chanch Colliery, Raniganj Field, (4) Specimen (D) from Chittidand Colliery, (5) Specimen (E) from Lamshiwall Mine, Makrewall Colliery and (6) Specimen (F) from Ledo 20 ft. seam, Assam.

Thermal decomposition of these coal specimens at 350°, 400°, 450°, 500°, 600°, 700° and 800 C has been then studied quantitatively. Distillations at 350°, 400°, 450° and 500°C were done under vacuum. Fuming sulphuric could not be used in these latter experiments for absorbing olefines. Concentrated sulphuric acid activated by traces of copper sulphate was found to absorb them readily with probably exception of ethylene and acetylene.

The yield of carbon monoxide was generally much higher in comparison with that of British coal. Thus with a typical British coal, the percentage of carbon monoxide was 6 by volume in the gaseous product calculated on carbon dioxide, sulphuretted and higher olefine free basis, the distillation being done at 400°C under vacuum[1]. Our highest figure for carbon monoxide is 40% and the lowest 21% under similar circumstances. The initial decomposition temperature was found to be in the neighbourhood of 400°C and the critical point was in the region 700°—800°C.

Correlation between the analytical and the distillation data has been sought. The distillation data

for 500°C under vacuum of the coal specimens are given below together with their analytical data.

Specimen No.	Data of Ultimate Analysis calculated on moisture and ash-free basis					Distillation data for 500°C (under vacuum)					
	% of C.	% of H_2	% of N_2	% of S	% of O_2	% of higher olefines	% of CO_2+H_2S	% of tar	% of liquor	% of coal residue	% of total volatiles
A	74·69	5·85	1·65	0·45	17·23	2·28	3·23	11·76	10·37	68·37	31·63
B	74·64	5·72	1·73	0·51	17·42	1·63	3·24	5·91	10·88	75·30	24·70
C	77·23	5·67	2·04	0·37	14·62	1·85	1·87	3·70	8·54	81·09	18·91
D	73·43	6·36	1·22	3·35	15·63	2·80	3·26	11·14	10·19	70·13	29·87
E	73·69	6·41	1·11	3·37	15·43	1·93	3·54	16·03	8·81	66·17	33·83
F	77·23	5·93	1·27	4·23	11·24	3·68	4·04	19·65	6·02	61·36	38·64

K. M. Chakravarty
Amarendra Nath Basu

Department of Chemistry,
Dacca University,
Dacca, 10-12-1943.

* We take this opportunity of thanking Sir J. C. Ghosh, Prof. S. N. Bose and Prof. J. K. Chowdhury for the interest they took in the above two investigations.

[1] Burgess and Wheeler, *Jour. Chem. Soc.*, 105, 136-38, 1914.

ANALYSIS OF SOME INDIAN COALS AND A STUDY OF THEIR THERMAL DECOMPOSITION UNDER VACUUM. Part II*

Proximate and Ultimate Analysis of the following specimens of coal has been carried out. (1) Coal from Ledo 20 ft. seam, Assam; (2) Coal from 14A seam in the Jharia Field and (3) Coal from Satpukuria seam, Raniganj Field.

These specimens have also been distilled under vacuum at 350°, 400°, 450° and 500°C and the products estimated quantitatively. The Assam coal was taken from the same stock as in the previous investigation. On comparison it was noticed that the ultimate analytical data were practically of the same order of magnitude but the distillation data were widely different generally. Since the interval between the two investigations was more than two years and the analytical data were not much at variance, this behaviour on distillation is to be attributed to some sort of internal chemical change going on at the room temperature within the coal.

The carbon monoxide yield in the other two specimens was high. Thus at 400°C the percentages of carbon monoxide were 14·7 and 33·1 respectively calculated on carbon dioxide, sulphuretted hydrogen and higher olefine free basis. The distillation results for 400° and 500°C of the Assam coal referred to above are given below along with the analytical data.

Specimen No.	Data of ultimate analysis calculated on moisture and ash-free basis					Distillation data for 400° and 500°C (under vacuum)						
	% of C	% of H_2	% of N_2	% of S	% of O_2	% of higher olefines	% of CO_2+H_2S	% of tar	% of liquor	% of coal residue	% of total volatiles	Temp. °C.
(1)	77·23	5·93	1·27	4·23	11·24	2·19	1·66	17·17	4·70	70·74	29·26	400
						3·68	4·04	19·65	6·02	61·36	38·64	500
Do. after storage for more than two years.	78·04	5·83	1·13	4·47	10·51	1·1	1·5	12·8	4·9	78·0	22·0	400
						2·0	2·7	15·3	10·6	64·5	35·5	500

Department of Chemistry,
Dacca University,
Dacca, 10-12-1943.

K. M. Chakravarty
Sudhir Chandra Shome

* We take this opportunity of thanking Sir J. C. Ghosh, Prof. S. N. Bose and Prof. J. K. Chowdhury for the interest they took in the investigation.

POLARISED FLUORESCENCES ON ACRIFLAVINE AND OTHER DYESTUFFS

IN continuation of our investigation[1] on the polarised fluorescence of organic and inorganic compounds in solution, very recently, we investigated in detail the polarisation of the fluorescent radiation emitted by Acriflavine, Bengal rose, Pinaflavol and others in viscous solution at different temperatures and concentrations under the excitation of lights of various wavelengths. In all the cases we observed that the average life of the excited molecules, though it depends markedly on the concentration, was independent of the viscosity, temperature of the solutions and wavelength of the exciting radiation, as will be evident from the following tables.

TABLE I.

AVERAGE LIFE OF ACRIFLAVINE IN GLYCERINE-WATER

Viscosity in poises	Excitation by λ 4358A		Excitation by λ 3650A	
	concentration $C=3.10^{-5}$ gm/c.c.	concentration $C=3.10^{-5}$ gm/c.c.	concentration $C=3.10^{-5}$ gm/c.c.	concentration $C=\cdot 8.10^{-5}$ gm/c.c.
1·65	$1{\cdot}2.10^{-8}$ sec.	$7{\cdot}5.10^{-9}$ sec.	—	—
·611	$1{\cdot}1.10^{-8}$,,	$6{\cdot}9.10^{-9}$,,	1.10^{-8} sec.	$6{\cdot}8.10^{-9}$ sec.
·367	$1{\cdot}3.10^{-8}$,,	$7{\cdot}1.10^{-9}$,,	$1{\cdot}1.10^{-8}$,,	7.10^{-9} ,,
·185	$1{\cdot}1.10^{-8}$,,	$7{\cdot}4.10^{-9}$,,	$1{\cdot}2.10^{-8}$,,	$7{\cdot}7.10^{-9}$,,

TABLE II.

AVERAGE LIFE OF ACRIFLAVIN AT DIFFERENT TEMPERATURES EXCITED BY λ 4358A.

Temperatures	Average life of the molecules		
	$C=3.10^{-5}$ gm/c.c.	$C=\cdot 8.10^{-5}$ gm/c.c.	$C=1{\cdot}1.10^{-5}$ gm/c.c.
30°C	13.10^{-9} sec.	8.10^{-9} sec.	—
40°C	13.10^{-9} ,,	9.10^{-9} ,,	6.10^{-9} sec.
60°C	13.10^{-9} ,,	9.10^{-9} ,,	6.10^{-9} ,,

Details will be published elsewhere in due course.

K. CHOUDHURY
S. M. MITRA

Physics Laboratory,
Dacca University,
Dacca, 27-1-1944.

[1] Mitra, *Ind. J. Physics*, **13**, 349, 1939.

PRESERVATION OF CRUSTACEA AND PREPARATION OF FISH-FOOD WITH THEM

PRESERVATION of Crustacea (lobster, prawns and shrimps) in this country is not very popular and is done in a very crude form. Ordinary drying in sun or preservation with salt gives the preserved objects a very bad smell. The bad odour, however, can be avoided if the Crustaceans be put in the washing soda-solution' after thoroughly cleaning them with cold water. In the case of big variety, such as, lobster outer chitinous covers and gills should be removed before treatment. Strength of the washing soda solution should be boiling water 1 litre with washing soda-powder 3 oz.

Method.—After dipping the Crustacea in the above solution for 5 minutes, put them in a solution of common salt (2 oz. to a litre of cold water) for a minute. Spread the treated material on a bamboo mat or on wooden tray for a fortnight for the purpose of sun-drying. When they are thoroughly dry, keep them in glass-jars with tight cover. Avoid cork cover ; the glass covers are the best. After packing avoid leaving any empty space in the bottle. This will enable keeping the dried Crustacea for a good length of time and can be sent to places where Crustacea are not available.

It is now an admitted fact that for ordinary purposes artificial food is no good for freshwater fishery but one has to depend upon artificial food for aquarium fish or for "jeol-fish" (*koi, singi* or *magur*) during transport by boat to long distances.

Crustacean fish-food can be prepared by powdering the dried Crustacea as stated above by a curry-stone and muller and then making pills with white of an egg or with *atta* or flour paste to the size of a pea. These pills can be given to "jeol-fish" during transport or to aquarium fishes for rearing.

We have experimented with these pills and have got very good results.

Zoology Department,
Calcutta University,
Calcutta, 5-2-1944.

H. K. MOOKERJEE

RETTING JUTE WITH CHEMICALS

THE biological process of retting (by which all the jute fibre of commerce is exclusively obtained from the plant) as practised in this country, is one over which the grower has very little control. On account of over- or under-retting, inferior fibre very often results even from good plants although the wise grower does his best to stop the process at the correct stage. It was considered worth while to investigate

the possibilities of chemical retting for obtaining a fibre of uniformly good quality. The results now described were obtained some time ago; they are mainly of theoretical interest at present, but it is considered desirable to place them on record.

Our knowledge regarding the natural process of retting is rather limited; it is, however, believed that pectin in the middle lamella of the softer parenchyma, which holds the fibre bundles together, is decomposed during retting, and that the fibre strands are thereby loosened from one another. The wood and surrounding tissues can then be easily separated mechanically from the fibre. Now, the constitution of pectin is not yet definitely known but that it is a polymerised form of galacturonic acid, some of whose carboxyl groups are occupied by calcium and magnesium, is more or less established. In chemical retting, the pectin has to be removed in the form of soluble salts, preferably by double decomposition. It was thought that water-soluble salts of sodium, potassium or ammonium with any acid (organic or inorganic) whose calcium and magnesium salts are *both* insoluble or practically so, would be good retting agents. A fairly large number of salts have been tried for retting jute plants or bark (green or dried) and in every case the above hypothesis has been found to hold good. Thus sodium sulphite is a good retting agent, (both Ca and Mg sulphites are insoluble in water) but sodium sulphate is useless (calcium sulphate is sparingly soluble but $MgSO_4$ is highly soluble in water). Ordinarily, a one p.c. solution of the salt at 70°—80°C for 1—4 hours is sufficient for satisfactory retting. Some of the results obtained are given above. The efficiency of a retting agent was judged by the ease with which the fibres could be separated from adhering tissues, after the treatment.

Name of Salt used	Solubility of corresponding salt in hot water (g. per 100 c.c.)		Retting action
	Ca	Mg	
Ammonium Oxalate	0·0014	0·08	Excellent retting agent.
Sodium Oxalate			Quite good.
Oxalic Acid			Useless at room temp.; attacks cellulose, jute powder is obtained at 70—80°C.
Sodium Fluoride	0·0017	0·0087 (cold)	Quite a good retting agent at 70—80°C.
Sodium Carbonate	0·0019	0·0106 (cold)	Useless at room temp. Quite effective at 70—80°C.
Sodium sulphite	0·0011	0·83	Good retting agent at 70–80°C.
Sodium silicate	0·0095 (cold)	insol.	Useless at room temp. for 10 days. Quite good at 70—80°C.
Sodium Phosphate (Na_2HPO_4)	0·02 (cold)	0·2	Quite effective.
Caustic Soda	0·077	0·0009 (cold)	No good at room temp. Quite effective at 70—80°C.
Sodium sulphate	0·1619	73·8	Absolutely no good.
Pot. iodate	0·95	33	Do. do.
Am. molybdate	insol.	sol. (cold & hot)	Absolutely useless.
Sodium oleate, palmitate, stearate (soap)	insol.	insol.	Quite good at 70—80°C.
Amm. acetate	29·7	66·4	Absolutely ineffective.
Amm. malonate	0·72	sol.	Useless.
Amm. Phosphate $(NH_4)_2HPO_4$	0·2 (cold)	0·2	Moderately good, less effective than (cold) Na_2HPO_4.
Am. citrate (Di) $(NH_4)_2C_6H_6O_7$, H_2O	2·1	slightly sol.	Effective in alkaline soln. but not in acid soln.
Sodium arsenate Na_2AsO_4, $12H_2O$	0·0048	insol.	Moderately effective, in alkaline soln. at 70—80°C.
Sodium succinate (normal) ..	0·89	soluble	Quite ineffective.
Sodium phosphate (tri) Na_3PO_4, $12H_2O$	0·002 (cold)	0·0205 (cold)	Quite good.
Ammonium Carbonate	0·0019	0·0106 (cold)	Practically useless, am. carbonate decomposes.
Ammonium hydroxide .. .	0·077	0·0009 (cold)	No good at room temp. and at 70—80°C., NH_3 escapes.
Sodium malonate	0·72	sol.	Worthless.
Sodium citrate (neutral) ..	2·1	slightly sol.	Fairly good.
Sodium chloride	59	73	Nothing at all.
Pot. Nitrate	102 (cold)	200 (cold)	
Sod. Pot. tartrate	0·0078	sol.	
Sod. tetra borate (borax) ..	insol.	sol.	Very slightly effective, perhaps due to NaOH set free.

It may be noted that a one per cent ammonium oxalate solution was found to be quite a good retting agent at room temperature (30°C), the time required was five days ; ammonium phosphate (but not sodium silicate) was also fairly good at room temperature—it required a week to ret the jute plant.

The dry bast contains about 65 per cent of fibre and 35 per cent of non-fibrous material. The CO_2—yield of the latter has been found to be about three times that of the fibre, indicating a correspondingly higher pectin content. It is estimated that the non-fibrous matter contains about 33 per cent of pectin. This result conforms with the idea that pectin is the material which cements together the tissues surrounding the fibre strands. The removal of this pectin by bacterial action in retting, or by double decomposition with certain salts in the manner already indicated, breaks down the tissues in which the fibre strands are embedded and makes possible the separation of the fibre by the well-known process of stripping and washing.

H. Chatterjee
C. R. Nodder
P. B. Sarkar

Technological Research Laboratories,
Indian Central Jute Committee,
Regent Park, Tollygunge,
Calcutta, 7-2-1944.

ATMOSPHERIC VORTEX STREET

One of the obvious difficulties of weather forecasting in India is that, owing to intense heating, the dry air is mostly lighter than moist air. Consequently, there is always a tendency for stabilisation of moist air.

For the last fifteen years, attempts have been made to devise a method of forecasting which would be equally applicable to daily and seasonal forecasting. The hypothesis, which has been found most useful in this connection, is that the atmosphere consists of vortex streets.[1] The vortex streets in the laboratory are known to diffuse quickly and are alleged to be of no practical use. Nevertheless, a geometrical method of forecasting by streets and fields has been developed. It is found to be peculiarly suited to Indian conditions.

It is said that an atmospheric vortex is a simple vortex with a forced vortex core. A study of the distribution of wind velocities in large horizontal sections, however, shows that the structure of the atmosphere is that of a series of more or less parallel vortex streets, some from an easterly direction whilst others are from a westerly direction. The diagram which shows the easterly and westerly streets, is from an unpublished atlas of normal atmospheric streets aloft in relation to the usual surface climatological data.

The diagram shows that an atmospheric vortex street consists of an infinite line of rectilinear vortices, each of which has a circular core of finite cross section, rotating like a solid cylinder. This is the "core cylinder" and no air from outside can enter this solid rotation. Its disintegration, however, may, in suitable circumstances, give rise to very high winds.

A row of cyclonic vortices is to be found on the northern side of a westerly and to the southern side of an easterly street. A row of anticyclonic vortices, on the other hand, is situated on the southern side of a westerly and northern side of an easterly street.

The wave length of a street is the distance between any two consecutive cyclonic or anticyclonic vortices. On the average, it increases with height up to 3—4 km. level in the generative field. The average wave length is of the order of 2,000 km. and the spacing ratio of the street about 0·5, measured on ordinary weather maps.

It is interesting to note that when two streets from the same direction lie side by side, they become bound gradually, though loosely, by developing common vortices. For example, the monsoon is not established until U_1 and U_4 combine by having a common anticyclonic vortex. The vortex, say H_{10} of U_4, therefore, progressively grows while the vortex H_2 of U_1 disintegrates in the pre-monsoon period. These streets are called *composite streets*.

The diagram shows that it is the relative motion and pressure between an easterly and a westerly street that gives rise to the deformation fields. According to the location of a westerly street to the north or south of an easterly street, two types of fields are usually in evidence, *viz.*, the A family fields and the B family fields respectively. The large deformation fields, no doubt, arise from the relative motion of composite streets or between unit streets of large wavelengths.

It is evident from the diagram that the anticyclonic lobes of the field A contain two anticyclonic vortices each and the cyclonic lobes of the field B, two cyclonic vortices each. The diagram also illustrates how the relative motion of the streets would give rise to *circumscribed areas*, cyclonic ($L_{14}N_7L_9N_6$) or anticyclonic ($H_2N_2H_6N_1$), as also the various states in which the fields can be.

In the presence of a spinless air mass, the symbolic representation of the vorticity of a field is the "double vortices" in a lobe. The field A is, as a rule, of anticyclonic vorticity and the field B, of cyclonic vorticity. Experience shows that anticyclogenesis in the field A is followed by cyclogenesis in the field B and vice versa.

In the diagram, the dilatation axes are shown in full lines and the compression axes in broken lines. It is interesting to observe that in the actual daily weather charts, an acute angle between the compression and dilatation axes holds, as a rule, the double anticyclonic vortices of the field A and the double cyclonic vortices of the field B. The approximate parallelism between the compression axes of one family and the dilatation axes of the other is obvious when a vortex is about to move.

In the Indian region, feeble pressure gradients are met with in the so-called seasonal troughs at the surface and also aloft between 4—6 km. levels in certain latitudes *e.g.*, the central parts of the country. These are the regions where a spinless air mass (straight stream lines) is available. It is obvious, therefore, that if a circumscribed area finds itself in this medium, circulation round a small part of the two long core-cylinders will ensure and vorticity will be shed. This is the generative field. A westerly and an easterly street will thus become "locked" and their relative motion will cease. The area $L_{14}N_7L_9N_6$ becomes a cyclonic cyclic field and the area $H_2N_2H_6N_1$ becomes an anti-cyclonic cyclic field. The *cyclic field*, therefore, is the natural forecasting unit.

The locking or belting process (which has its own peculiarities) gives rise to an expanded vortex. It is apparently affected by temperature variations which may account for the diurnal variation in the intensity of free vortices. It is mostly in this expanded portion that the initial growth of free convection, upwards in cyclogenesis or downwards in anti cyclogenesis, is to be sought. In this connection, it has to be remembered that each street, when pressed, develops its own humidity wave which has a dry and a wet phase. The wet phase is often marked in a composite or "transitional" during the monsoon street.

An expanded vortex behaves like a cylinder with circulation round it. When placed in a cyclic field this cylinder experiences a "thrust" directed from the weak to the strong winds round the cylinder. This pressure is of the same nature as the well known "lift" in aeroplanes.

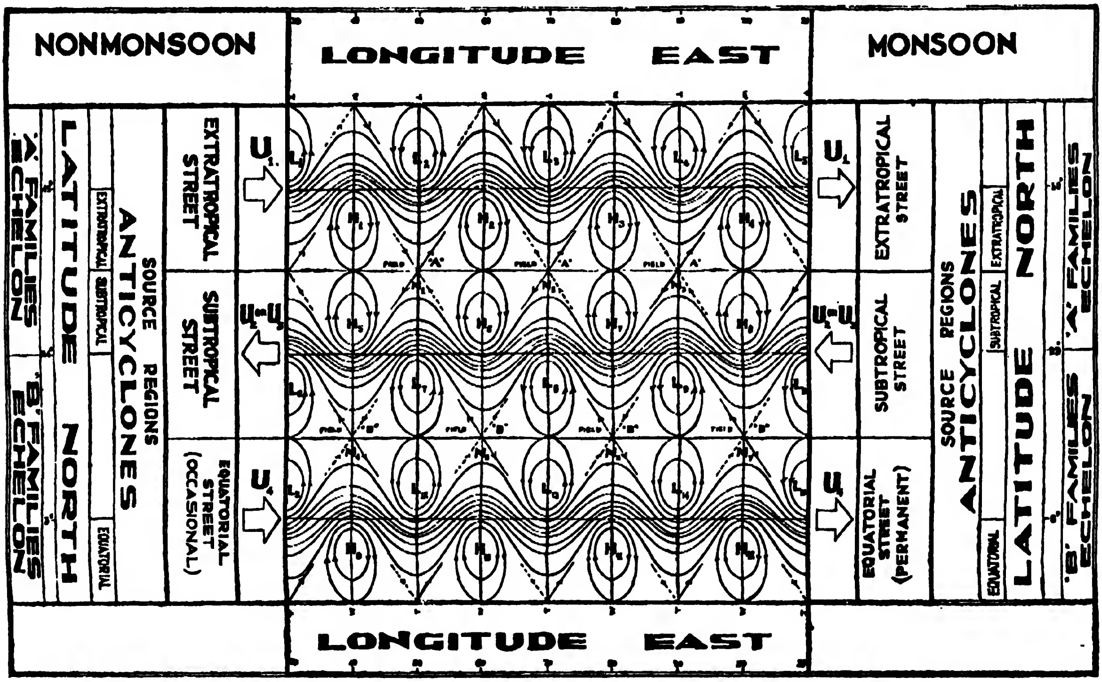


Fig. 1. The Atmospheric Vortex Streets—Birth of Deformation Fields.

It is an interesting fact that the field A persists above the 5 km. level over the Indian region, even during the monsoon. The motion of the neutral point of this field simulates the motion of the sun. In the case of cyclones, the anticyclonic lobe of equatorial air of this field aloft may provide the external force or "drive" which acts through the axis of the core-cylinder. Remembering the parallelism between compression and dilatation of the A and B family fields, it at once becomes apparent that a vortex can move as one entity only when the "thrust"

is perpendicular to the "drive". The case of "recurving" cyclones has also been studied.

The details will be published elsewhere.

Meteorological Office,
Clifton, Karachi Sadar, S. N. SEN
Dated 14-2-1944.

[1] Sen, S. N., SCIENCE AND CULTURE, 9, 90, 1943.

WANTED A 'ROSTER OF SCIENTIFIC PERSONNEL'

It is a welcome sign of the times that Indian scientists are now enthusiastically discussing about post-war scientific planning. The ball has been set rolling by the National Institute of Sciences of India and by the SCIENCE AND CULTURE. In his Annual Presidential Address to the National Institute of Sciences of India, Sir Jnan Chandra Ghosh has referred to President K. T. Compton's description before the Royal Society of the war-time scientific organisation of the United States of America. The 'first step' that was taken in America in this connection was the establishment of a 'National Roster of Scientific and Specialised Personnel' and with the information available from this source, several organisations such as, the Office of the Scientific Research and Development (O. S. R. D.), National Defence Research Committee (N. D. R. C.), etc., were created so that the scientific talent and resources of America could be effectively harnessed towards her National Defence programme.

In order that Indian scientific workers may render whatever useful service they are capable of towards the Empire war effort *now* and also towards building India's destiny in the realm of science *in future*, Sir Jnan Chandra Ghosh has rightly suggested the formation of a 'National Research Council'. This will undoubtedly be a step in the right direction.

While plans are being finally chalked out and attempts are being made to secure an adequate financial allotment from the Central Exchequer for this worthy cause, it seems very desirable that India should start *immediately* with the compilation of a 'National Roster of Scientific and Specialised Personnel'. This is the *first step* in any organised planning and if carefully done under expert supervision, will provide the necessary information for quick drafting into the specialised services of all organisations or institutions that the country will need to set up in connection with her national defence, post-war rehabilitation, and industrial regeneration.

It seems to me that the 'Indian Science Congress Association' which has already helped in the organisation of scientific personnel much more than any other single scientific body in India, should legitimately take up this work without further loss of time. The 'Roster' should be jointly administered by such bodies as the National Institute of Sciences of India (Calcutta), the Indian Academy of Science (Bangalore), the National Academy of Science (Allahabad), and the Indian Association for the Cultivation of Science (Calcutta), so that full co-operation would be secured from all quarters in India. The executive and co-ordinating officers and offices may operate from a suitable centre, say, Calcutta, where the Indian Science Congress Association has its headquarters. Almost all the information required can be obtained through the co-operation of such bodies as the Indian Chemical Society, Indian Medical Association, Indian Physiological Society, Biochemical Society, Society of Biological Chemists, Institution of Chemists (India), Indian Institute of Engineers, Indian Statistical Institute, Botanical Society, Zoological Society, Anthropological Society, etc., etc., and also by the issue of a 'Questionnaire' all over India. It should be made clear at the very outset that all information submitted will be held *confidential*. Some of the points against which information is considered helpful are given here to serve as a guide:

1. Name and address; 2. Date of birth; 3. Place of birth; 4. Citizenship (not necessary in India); 5. Marital status, dependents; 6. Race and sex; 7. Military service; 8. Proficiency in foreign language; 9. Government service—Central or Provincial or State; 10. Foreign travel and residence; 11. Physical condition; 12. Height and weight; 13. Name of at least 3 referees competent to judge ability with their addresses; 14. Statement of college or university education or affiliation with scientific societies; 15. Any profession or semi-professional occupations or other skill acquired through study, habits, construction of instruments, etc.; 16. List of all significant full-time position held including present position; 17. The order of competence (beginning with major field of competence, secondary field, etc.) not exceeding 5 of the special fields, giving number of years spent in each 'function'; 18. The principal professional field (If in a special branch or field, as organic chemistry, such branch should be indicated. If in a borderline field, choice for grouping in a particular category, for example, a physicist or an electrical engineer, a physiologist or a physician, etc., should be mentioned); 19. List of special scientific or professional apparatus or other mechanical devices which you are competent to use; 20. List of other part-time or temporary positions; 21. List of principal contributions, *e.g.*, publications, inventions, patents, etc.; 22. Any research or special work in progress; 23. Any conditions which would make it difficult for part-time consulting or full-time service; 24. What Committees or other Organisations are you associated with? Full title and address of the laboratories or other research organisations, if any, with which now associated. (The information should be given in such a way that it can be used in compiling a list of active research laboratories and organisations of the country). 25. Fields and avenues to be taken up for special service to the country.

The work will naturally involve a large office staff and preferably a full-time Director or Chief. If card indexing system is started from the beginning, grouping would be easy. A full-time statistician 'Secretary' would also be needed.

The finances needed would not be very heavy as with proper understanding and co-operation amongst

all concerned, expenditure on such items as office accommodation, electricity, stationery, postage, etc., could be reduced to a minimum. The full-time Director and Secretary should be decently paid; otherwise the work, which in its very nature, is bound to be rather tedious, would not proceed smoothly. The money can be secured by pooling the reserves from many scientific organisations, *e.g.*, Board of Scientific and Industrial Research, National Institute of Sciences of India, etc., and by making an appeal to the industrial interests and the general educated public. Government of India can also be approached for a *non-recurring* grant. If enthusiastically pushed, a period of not more than 8 months to 1 year should be sufficient for the job. A lakh of rupees, which should be considered the minimum budget for such a comprehensive undertaking, is not beyond the capacity of India.

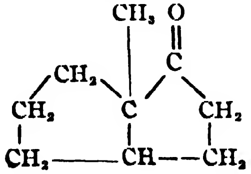
The scheme is of such vital importance to both Government and the industrial organisations that the money necessary should be found, if the significance of the project is clearly brought home to the educated public. This can be done through the columns of SCIENCE AND CULTURE and other journals and newspapers devoted to scientific, industrial, social and professional interests.

B. MUKERJI

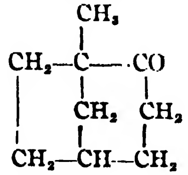
Biochemical Standardisation Laboratory,
Govt. of India,
Calcutta, 26-2-1944.

ON THE SYNTHESIS OF 7-METHYL-0:3:3-BICYCLOOCTANE-1-ONE

Previously a synthesis[1] of 7-methyl—o:3:3-bicyclooctanone (I) was described. The constitution assigned to the above compound was mainly based on the observations of Baker.[2] But quite recently Chakravarty[3] has definitely proved that ethyl β-methylbutane—α, β, δ-tricarboxylate on condensation with sodium yields, contrary to the observations of Baker, ethyl-4-methylcyclopentane-1-one-2: 4-dicarboxylate instead of ethyl 3-methylcyclopentane-1-one-2: 3-dicarboxylate; further he has shown that the melting point of the dicarboxylic acid, obtained by the oxidation of the bicyclic ketone prepared by me, is identical with that of 1-methylcyclopentane-1-carboxylic-3-acetic acid. So that, on the basis of the latter observation the bicyclic ketone mentioned above should possess the configuration (II).



I



II

In the following lines, a synthesis of *cis* 7-methyl-o: 3: 3-bicyclooctane-1-one by a method similar to that adopted by Bachmann[4] *et al* for the building up of the cyclo-pentanone ring in the synthesis of equilenin, has been described. 1-Methylcyclopentane-1-carboxylic-2- acetic acid, which has been used as the starting material, was prepared by the condensation of ethyl cyanoacetate with ethyl 2-methylcyclopentanone-2-carboxylate, followed by reduction with aluminium amalgam and hydrolysis, with the hope of obtaining the *trans* isomer as prescribed by Linstead *et al.*[5] The above Knoevenagel condensation, however, was carried out according to the modified method of Cope *et al*[6] instead of the high pressure technique used by Linstead and a much improved yield (62%) of the condensation product was obtained. But the 1-methylcyclopentane-1-carboxylic-2-acetic acid, thus prepared, was found to be a mixture of *cis* and *trans* forms, from which by repeated crystalisation we have so far been able to isolate the *cis* acid (m.p. 111-112°) in the pure form. The dimethyl ester of the above acid (b.p. 101°/3·5 mm.) on partial hydrolysis with alcoholic alkali yielded 1-methyl-1-carbomethoxycyclopentane-2-acetic acid (b.p. 144°/4 mm.). The latter was converted into its acid chloride (b.p. 103°/4 mm.), which on treatment with diazomethane and silver oxide and methyl alcohol yielded methyl-1-methyl-1-carbomethoxycyclopentane-2-β-propionate (b.p. 120°/4·5 mm.). The above dimethyl ester was cyclised by means of sodium and the resulting methyl 7-methyl-o: 3: 3-bicyclooctane-1-one-2-carboxylate (b.p. 100°/4 mm.) was hydrolysed by refluxing with an excess of 20% sulphuric acid, when 7-methyl-o: 3: 3-bicyclooctane-1-one (b.p. 80-85°/15 mm., semicarbazone m.p. 181-182°) was obtained in good yield. The bicyclic ketone, thus obtained, on oxidation with nitric acid, yielded a dicarboxylic acid, which after once crystallisation from water melted at 111-112° and the melting points remained undepressed on admixture with an authentic sample of *cis* 1-methylcyclopentane-1-carboxylic-2-acetic acid.

My best thanks are due to Prof. P. C. Mitter for his kind interest in the work.

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Calcutta, 7-3-1944.

[1] Banerjee, *J. Ind. Chem. Soc.*, **17**, 423, 1940.
[2] Baker, *J. C. S.*, 1548, 1931.
[3] Chakravarti, *J. Ind. Chem. Soc.*, **20**, 173, 189, 247, 1943.
[4] Bachmann, Cole and Wilds, *J. Am. Chem. Soc.*, **62**, 824, 1940.
[5] Linstead and Errington, *J. C. S.*, 666, 1938.
[6] Cope, Hofmann, Wyckoff and Hardenbergh, *J. Am. Chem. Soc.*, **63**, 3452, 1941.

ERRATA

In the article on 'Delhi and its Monuments' published in the January, 1944 issue, the following errors crept in.

Page 10,	Col. 1,	line 7	...	*Delete* (1400 B.C. ?)
,, 11,	,, 1,	,, 13	...	*For* "An Inscription of . . . . knew it not." *Read* "An inscription belonging to the reign of one Bhojadeva identified by scholars with the celebrated Bhoja I of the Pratihara dynasty (c. 836—c. 882 A.D.) has been found in the neighbourhood. But Albiruni does not appear to have heard of the city's name.
,, 11,	,, 1,	,, 20	...	*For* "the epigraph . . . . . aforementioned" *read* "the Rajput epigraph mentioned in the preceding paragraph".
,, 11,	,, 1,	,, 22	...	*For* "about 950 A.D." *read* "1052 A.D.".
,, 11,	,, 1,	,, 23	...	*For* "about 1060 A.D." *read* "some time before 1064 A.D.".
,, 11,	,, 2,	,, 4	...	*For* "1226 A.D." *read* "1826 A.D.".
,, 12,	,, 1,	,, 21	...	*For* "built for himself near the Alai Darwaja" *read* "built for himself, and very near the Alai Darwaja".
,, 12,	,, 2,	,, 19	...	*For* "(1761– 1803)" *read* "(1761—1806)".
,, 12,	,, 2,	,, 20	...	*For* "(1727—1746)" *read* "(1600—1743)".
,, 13,	,, 1,	,, 1	...	*For* "(1857)" *read* "(1862)".
,, 13,	,, 1,	,, 45	...	*For* "Khusru" *read* "Nasiruddin".
,, 14,	,, 1,	,, 52	...	*For* "Qutb" *read* "Qutb Sahib".
,, 15,	,, 1,	,, heading	...	*For* "Puran" *read* "Purana".
,, 15,	,, 2,	,, 8	...	*For* "Qutsiya" *read* "Qudsiya".
,, 16,	,, 1,	,, 17	...	*Delete* "in some respects".
,, 16,	,, 2,	,, 11	...	*For* "founder of the Oudh family" *read* "the second independent Nawab of Oudh".
,, 16,	,, 2,	,, 1	...	*For* "previous" *read* "precious".
,, 18,	,, 1,	,, 8	...	*For* "1727—1746) *read* "1699—1743)".
,, 18,	,, 1,	,, 28	...	*For* "character" *read* "hero".

In the article entitled 'Planning for Nutrition' (March number) in page 375, col. 2 *omit* " ,, " after "15 billion", *Read* "Green leafy Vegetables, 20 million tons" after "Fruits" in the table and in page 376, col. 1, *read* Calciferol "1·5" *for* "1500" at the end of the table. In the footnote on p. 375 *read* "1944" *for* "1943".

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PLANNING AND PROSPECT

PLANNING for the country on a comprehensive basis has been the all-absorbing programme of Soviet Russia ever since 1928. The idea of industrial and economic planning on a national scale was first introduced in this country by Sir M. Visvesvaraya in 1935. Very few people in this country appear to have appreciated his ideas, but from its very inception in 1935, this journal has been trying to mobilise public opinion in this country for a programme of national development by harnessing science and technology in a planned manner. It was largely due to our advocacy that the then President of the Indian National Congress took the first steps in this country to start the actual work of detailed planning and constituted for this purpose the well-known National Planning Committee with Pandit Jawaharlal Nehru as the Chairman. That work, though unfortunately interrupted by the incarceration of the Chairman, brought the idea of planning to the fore and resulted in a large collection of materials and formulation of tentative schemes, which may perhaps be published in happier times. The work was inspired by realistic idealism and under the inspiring guidance of Pandit Jawaharlal Nehru some of our best intellects in the domains of science, economics and industry and in our national life gave ungrudgingly their time and labour. The vastness of the scope of the work may be indicated by the fact that for the preparation of the detailed reports, the Committee constituted no less than 28 sub-committees for dealing with various subjects. The amount of work put in by the Committee and its various sub-committees is an index to show how much can be achieved in a relatively brief space of time when a genuine love of the country under inspiring leadership provides the driving force. Summaries of recommendations of several sub-committees were published in the press, and others were almost complete when the work was interrupted.

WHY PLANNING?

Although planning is now in the air, it may be useful to restate the reasons for planning. The amount of interest shown by all sections of the public showed clearly the appreciation of constructive thinking on a programme of such vast general importance. But even now in interested quarters the question is asked why planning should be necessary for the economic development of India, when countries such as Britain, Germany and U. S. A. have reached their present pre-eminence without any planning from the top. Why not *laissez faire*? *India shall forget the answer at her own peril.* The aforesaid countries started their industrial revolution more than a century ago by the use of scientific and technological discoveries made in the West. In a largely undeveloped and uncompetitive world their scientific and technical superiority helped them to acquire not only the economic hegemony of the world, but also military and political hegemony. The results of those conquests are now obvious to all. If today India wishes to proceed to develop her industrial and agricultural economy without any plan, centrally conceived and centrally directed, she will only find herself economically outfought by the incomparably more advanced countries. India requires therefore a planned and a *forced* march under the driving force of her own Government if she is ever to fight her way out of the present axis-combination of poverty, disease and illiteracy.

But it is not at all correct to say that even in the U. K., U. S. A., and Germany a policy of *laissez*

faire has been followed. The need of some sort of planning and central direction is being felt even in these industrially advanced countries. If not for anything else, at least for securing greater equity in the distribution of wealth, for avoiding cut-throat competition among the different industrial concerns, for limiting those "anarchic" conditions which develop with the growth of uncontrolled capitalism under the motive of profit, for ensuring a more balanced structure of production necessary for the all-round strength and prosperity of a nation which ought to be the concern of the State and *above all* for conserving exhaustible national resources like coal and petrol and developing power and mineral resources planning is being increasingly considered even in the highly capitalistic countries. England has got, for instance, her political and economic planning (PEP) groups and during the war the State has intervened more and more in regulating production and is already planning for the post-war period. The generation of electrical power has been completely State-controlled since 1927, and the production and utilisation of fuel has largely come under planned control in recent years. In America capitalistic genius had in the past received free play and had reached perhaps the highest water mark of efficiency. But President Roosevelt, since his accession to Presidentship in 1932, has introduced 'National Planning' under the name 'New Deal', and within the last twelve years, vast development projects like the Tennessee Valley Reclamation, The Boulder Dam, The Grand Coulee Dam, etc. have been completed. These schemes, which could never have been completed without State intervention, and premeditated planning, have enormously enhanced U. S. A.'s productive power; the T. V. A., established in 1933, alone produces about twice the electrical energy produced in India, and the total increase in electrical energy-production due to the 'New Deal' will be about 50,000 million units, almost equal to Germany's production of electrical energy in 1939. But 'planning' has not been confined to such vast reclamation works alone. After the fall of Malaya, a plan has been framed by the Compton-Conant-Bharuch Committee for the production of synthetic rubber, whereby a balanced production is secured from petroleum on the one hand and alcohol, derived from the fermentation of grains, on the other. Both industrial and agricultural interests have thereby been secured, which is the ultimate objective of national economy as a whole. This plan is now being loyally implemented by the Government and the interests concerned. This and other vast production works like production of aluminium, fertilisers, chemicals could not have been so speedily undertaken if Roosevelt had not the foresight to develop hydro-electrical power, as a part of reclamation scheme.

Russia

The finest and untrammelled fruition of planning has, of course, been achieved in the Soviet Union where a clean slate was provided by the abolition of the inherent contradictions of capitalist society altogether. What the Five Year Plans, starting only in 1928, have achieved for the Soviet Union, is now clear to all. Her industrial and agricultural strength built up in the space of barely 15 years by a forced and planned march has stood up to the test of the most fiery ordeal that any country has known in history. In this march, which was proving too strenuous and exhausting for many people, Stalin provided great inspiration and guidance as will be seen from his address in 1931:

> "It is sometimes asked whether it is not possible to slow down a bit in tempo, to retard the movement. No, comrades, this is impossible. It is impossible to reduce the tempo. On the contrary, it is necessary as far as possible to accelerate it. To slacken the tempo means to fall behind. And the backward are always beaten. But we do not want to be beaten. No, we do not want this! The history of old Russia is the history of defeats due to backwardness. All beat her for backwardness. . . They beat her saying 'You are abundant, so we can enrich ourselves at your expense'. They beat her saying, 'You are poor and helpless, so you can be beaten and plundered with immunity'. You are backward, you are weak, so you are wrong, hence you can be beaten and enslaved. You are mighty, so you are right, hence we must be wary of you. That is why we must no longer be backward. . . . . We are fifty to hundred years behind the advanced countries. We must cover this distance in ten years. Either we do this or they will crush us".

Today the war has revealed Russia's strength secured at colossal sacrifice. Today she makes all the highly mechanised equipments that a modern military power needs.

On the other hand, as the war has intensified, India's industrial and agricultural backwardness, has been increasingly brought home to us almost in every aspect. India made no tanks, aeroplanes, trucks or cars. We made hardly any basic chemicals, dyes or synthetic drugs. Engineering, metallurgical and chemical industries which are absolutely pivotal to a country's development were practically non-existent Probably there can be no better index to India's backwardness than the incontrovertible facts that her production of electrical energy is still 7 units per capita, and energy from coal is about 12 units per capita. One has only to compare these figures with that of 2,000 for the U. S. A., from all sources, to realise India's backwardness. Agriculture produces less rice and less wheat per acre than any country in the world. The level of literacy is likewise the lowest and therefore educated and trained personnel and labour are largely lacking. Famine and epidemics have supervened and people have died in hundreds of thousands

from starvation and from easily curable and preventable diseases for lack of drugs and preventive agents. In five months in Bengal alone about 7 lakhs of people perished owing to the famine and its aftermath, according to a Government communique, while barely 1·6 lakhs of people have been killed in four years in this war in the whole of the British Empire, as stated by Mr Churchill in Parliament on April 4, 1944. Such a shambles could scarcely be imagined if it were not so real.

The Bombay Plan*

The question of rapidly getting out of this valley of death, poverty, disease and illiteracy is therefore the vital problem for India. Recently some well-known industrialists of India have produced a tentative plan, popularly known as the "Bombay Plan", for this accelerated development. This plan has attracted wide-spread attention. Explaining why there should be a plan—a point which we have discussed above—one of the authors, Mr J. R. D. Tata said in an address at the Bombay Rotary Club on the 15th February, 1944:

> "While it is true that the great prosperity has been built up in other countries, and particularly in America, without any centralised planning and control, the conditions facing us in India to-day are entirely different. Climatic disabilities, the gradual erosion and de-mineralization of our land, the progressive loss of vitality, the political subjection and economic degradation of the people, the massive increase in our population, has brought the nation to a state where, like a patient exhausted by a long illness, it lacks the vitality and capacity to fight back to health unaided. The progress towards recovery that could be achieved in the natural course of things would be too slow. We cannot wait a hundred years or even half that time. There is no margin of safety left, as the recent tragedy in Bengal has shown us."

This is but too true.

The plan envisages doubling of the standard of living of the Indian people over a period of 15 years covering the essentials of life, *viz.*, food, clothing, shelter, health and education. The per capita annual income of Rs. 65/- is sought to be increased to about Rs. 135/-. This is a far more modest idea than that of the N. P. C. Taking into account the probable rise in population to about 490 millions during the 15-year period, this would mean a three-fold increase of the annual national income from Rs. 2,200 crores to Rs. 6,600 crores. This increase in the national income means, of course, more production. Apart from the over-all increase in production, the plan seeks to organize a more balanced structure of production. Thus agriculture and industry are expected to contribute respectively 40 per cent and 35 per cent of the national income as compared to about 55 per cent and 17 per cent today. The rest of the income would be contributed by the services.

The plan then considers the outlay necessary for securing this increased national income and indicates the following figures for investment under different heads spread over 15 years:

	Crores of Rupees
Industry	4,480
Agriculture	1,240
Communications	940
Education	490
Health	450
Housing	2,200
Miscellaneous	200
	10,000

For purposes of execution it has been proposed that the scheme should be divided into three 5-year plans and that the investment should increase in geometric progression from one period to the next. It should be stated, however, that the plan would naturally help to pay its way as production increases.

Regarding priorities in production, more emphasis is rightly laid on the development of basic industries than of industries for consumption goods, although to avoid hardships as far as possible the latter are also proposed to be developed along with the basic industries but on a relatively smaller scale particularly during the earlier stages of industrialisation. It is only too apparent that in this country whatever industrial development has taken place is largely a spurious lop-sided development (except in the iron and steel and some other industries). Thus sugar and textiles are produced in fairly large quantities but sugar and textile machineries have largely to be imported.

In our opinion, the plan is neither so broad nor exhaustive as that of the N. P. C., but it is to be welcomed that our industrial magnates have been able to come out of their narrow grooves, and think in terms of the Nation. No doubt the idea has been accelerated by the large accumulation of surplus money which has flown into their coffers. Vast constructive works on a national basis, which India badly needs, will provide a channel for this 'capital', and make it *creative*. If such works are not undertaken, this 'capital' will produce, as it has already produced, 'inflation'; and poverty, disease and degradation will continue.

Some criticisms have been made against the plan. It is said, for instance, that it is a scheme to benefit the Indian industrial magnates. Perhaps, but would

* '*A Plan of Economic Development for India*' by Sir P. Thakurdas, J. R. D. Tata, G. D. Birla, Sir Ardeshir Dalal, Sir Shri Ram, Kasturbhai Lalbhai, A. D. Shroff and John Matthai.

we prefer the present backward condition which is exploited and perpetuated by *foreign* industrial magnates? Would the British people prefer American capitalists to their own? It is true, of course, as we have indicated above, that it is *socialist* planning as that adopted in Russia which allows the full fruits of planning to be reaped by the entire community on an equitable basis. As a matter of fact the Bombay Plan itself recognises the necessity of a National Planning Committee functioning under a free National Government to frame the detailed schemes, the execution of the schemes being in charge of a "supreme economic council working alongside the national planning committee under the authority of the Central Government". The problem of distribution is referred to as "vital" but this and the "allied question of the control to be exercised by the State over economic activities" are expected to form the subjects of a later report.

The question of finance is complicated and has been proposed to be raised both internally and externally. The question of possible inflation is also touched on. The Soviet Union had to rely chiefly on internal finance and by exporting food-grains at great sacrifice secured part of the necessary capital goods. In this country, similarly, we can hardly bypass toil and sweat and tears if we wish to compress a century's development into a quarter of a century.

The plan fully recognizes that without a National Government such a plan of development cannot be adopted. We would add that that National Government will also have to keep in view the good of the entire community and the even distribution of wealth in framing and executing the future National Plan. The fruits of planning should, on no account, be allowed to be frustrated by sectional, group or individual or provincial interests, which run counter to the good of the community.

The Prospect

The planning may be there but what is the prospect? The Government of India and also the Provincial Governments have appointed a number of post-war reconstruction committees. The terms of reference of these committees are so circumscribed that they have hardly inspired any confidence, but more commendable are the proposals of the National Institute of Sciences of India for a National Research Council for dealing with scientific research in a comprehensive manner embracing scientific, industrial, agricultural, medical, public health and engineering research. In order to see that the results of research may be implemented in actual practice the National Institute have also recommended that the proposed National Research Council should have corresponding Development Sections in the relevant Departments of the Government. There is also the proposal for a Government Member in charge of Research and Development. These are all progressive steps, but all of these including the Bombay Plan cannot replace a National Planning Committee or a State Planning Commission for centrally directing and integrating a plan of national development with its myriad criss-crossing strands. Above all, the will and driving force of the State organ is necessary not only in framing the highly complex National Plan but particularly in executing it in a stated period of time.

Government spokesmen have on several occasions professed a desire for the industrial development of India. But it is curious to note that, not to speak of Government's framing a full-fledged scheme of industrialisation, whatever planning has been made by others has received very little commendation from the Government. Sir Jeremy Raisman said that the Bombay Plan was going to impose too great hardships on the people. The die-hard Tory papers, the London *Times* and the London *Economist* thought that it was largely unpractical. Far more ambitious projects are apparently practical in the Soviet Union and are highly commended by the British allies of the Russian Soviets, but even modest schemes for doubling the standard of living in 15 years are according to the same critics apparently not practicable in India!

There are already disturbing signs of a double-pronged attack on Indian industries including those which have been started owing to the Government's own war needs. On the one hand, facilities for these industries are being restricted and in wartime it is Government alone who can accord those facilities and, on the other, Government are helping the import of consumers' goods with the object, as they say, of counteracting inflation. This pincer movement is bound to kill a number of Indian industries. Of late even alum, dichromate, sodium sulphide, 'hypo' and many other chemicals, which were already being made in India, are being provided shipping space for importation into India, inspite of the supposed pressure on shipping, which prevented the Government to get food to India for a considerable period during the famine. The arguments advanced by the Government for this policy are interesting and worthy of critical examination.

(*a*) It is said that there is shortage of coal, transport and other essentials necessary for Indian industries. It will be noted, however, that the British Government is maintaining the British industries for which an essential requirement is coal, inspite of the fact that there is a serious shortage of miners' labour in Britain and there have been serious coal strikes entailing a loss of several million tons. If coal had

been withheld from British industries, how could they increase the export of finished goods besides maintaining the war and the civil industries of Britain? Apparently the British Government on plea of coal shortage is not starving their industries. Why do the India Government starve ours?

(*b*) It is said that many of the Indian industries are "uneconomic" and therefore they ought to be discouraged. Such arguments are apparently not advanced in Britain, U. S. A., Canada or Australia with regard to their own industries. Industries may be said to be "uneconomic" if in peace time under conditions of free trade they cannot produce and sell goods at a price at which they can be imported. Judged by this standard, the production of dye-stuffs in Britain was uneconomic compared with that in Germany. Then why was not the British industry discouraged by the British Government? In every country the economics of production improve with time and if industries are nipped in the bud, how will they ever get a chance to reduce the cost of production? A fine example is afforded in India itself, where the sugar industry, on account of the protection it has enjoyed, has not only effected an all-round improvement, (*e.g.*, the recovery has increased from 6—7% in 1931 to 11% in 1943), but has been giving of late a far larger amount to the Central Exchequer in the form of excise, and income tax than the Government ever used to realise from customs duty on sugar imported from Java previous to 1934. Were not practically all Soviet industries uneconomic in the beginning? If so, why did not the Soviet Government suppress them? The fact is that an all-round industrial development is regarded as essential in every progressive country, firstly because it is needed for prosperity, and secondly because it is essential for defence. Apparently that principle does not apply to India.

(*c*) It is said that importation of consumers' goods is necessary in order to fight inflation. But inflation can also be fought by producing those goods in one's own country. In fact, Lord Wavell stated in the Central Legislature on 17th February, 1944 that inflation should be fought by both these methods. Accordingly, the Government recently announced that they were vigorously moving for increased imports of finished goods into India. But the Government did not say what vigorous steps they were taking to increase the production of those goods in this country. Can any other country be mentioned where finished goods are being deliberately imported to fight inflation? Is it not rather a fact that every country of any importance is increasing its home production of consumers' goods not only to fight inflation but to maintain foreign markets even during the war? In fact, as we have mentioned earlier, the present surplus wealth in the hands of the Indian industrialists and the public can flow into creative channels, and can materially help to solve India's poverty problem if the Bombay scheme is adopted. But if that is not adopted, this wealth will become inflative and enhance the poverty.

(*d*) Facilities for importation of plants, machineries and basic materials, etc., are often refused to Indian industries on the ground that shipping space is saved by importing the finished goods rather than those heavy materials. One may ask how Britain gets the enormous shipping space necessary for importing heavy raw materials from distant countries from which British industries manufacture finished goods to sell often in countries, wherefrom these raw materials are imported. Sir Gilbert Morgan, an authority on British chemical industry, stated "Apart from coal and iron ores, the mineral resources of the United Kingdom are relatively limited and many of our metallurgical trades depend on sea-borne minerals". If Britain now sends finished goods for fighting inflation in India, it is obvious that the British Government provided very large shipping space for importing enormous quantities of heavy raw materials. Then why should shipping space be unavailable for importing machineries and basic starting materials for Indian industries?

(*e*) As is well-known, industrial activity has been restricted in India by the restriction on the starting of new concerns and even on increasing the share capital of existing concerns, in the name of protecting the prospective investors, who might otherwise be cheated. We doubt whether there are similar restrictions in Britain or U. S. A. In any case, one should have thought that, since fighting inflation is one of Government's objects, they should have encouraged fresh investments of capital for the manufacture of consumers' goods in India.

The above would show the wide gulf between Government's professions and actions and this hypocritical policy is already in operation. These policies would be more intelligible in the light of the following press report from London:

"Expert economists here see danger for post-war Indian trade and industrialisation in India in Lord Woolton's (Minister for Post-War Re-construction in Britain) speech today. Lord Woolton envisaged:

(1) statutory provisions for securing adequate British exports to India and the Empire,

(2) gradual export of investment capital to the Empire under State auspices and

(3) increase of invisible exports under cover of an expansionist policy. . . . .

British post-war prosperity is to be built up gradually on the above 3-point plan. British manufacturers and financiers are at present planning means to strengthen the economic control on India by exporting investment capital and by

increased exports of manufactured goods. The future Indo-British trade is bound to be based on bartering of raw materials for consumer goods. Experts declare that this policy will hinder Indian industrial development until such time as India can politically be free to devise and execute her own economic policies" (*Hindusthan Standard*, 20-3-1944).

Satisfactory answers could not be elicited from the Government when questions were asked by Mr T. T. Krishnamachari in the Central Legislative Assembly on March 20, 1944, regarding the activities of the United Kingdom Commercial Corporation and the Imperial Chemical Industries. He said that the I. C. I. had a stranglehold on Indian industries and also referred to the statement said to have been made by the Chairman of the I. C. I. that if a concern was as large as the I. C. I., its interests became identical with those of the nation (British) as a whole. The prospect before many Indian industries is therefore bleak indeed.

Planning is possible and desirable. But planning without power only make us conscious of our lack of power. It is like a river channel without the vivifying water.

Indian industrial concerns should have no illusion about the Government's actions in the years to come. They should put their heads together and devise methods for fighting the menace.

STANDARDISATION OF ELECTRICAL QUANTITIES—THE MODERN TREND OF ACCURACY

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THE purpose of standardisation is to specify characteristics such as size, value, performance, quantity, etc. of commodities with a view to obtaining reasonably uniform performance from them. As an illustration, the case of incandescent lamps may be cited. These are nowadays standardised : this means that certain specifications are drawn up regarding such essential characteristics as the power consumption, luminous output, the cap size and so on of each type of lamp; and, a standard lamp should conform within certain specified tolerances to these specifications. Whether or not these specifications are satisfied by a particular sample is determined by actual measurements. Thus, standardisation has two distinct aspects. Firstly, the drawing up of standard specifications which should be comprehensive enough to determine the performance of a commodity unequivocally and secondly, the development of methods of measurement for checking with precision whether these specifications are complied with or not.

The Advantages of Standardisation

Standardisation has numerous advantages, and some of the more important ones may be mentioned here for illustration.

1. Standardisation assures easy replaceability. This is perhaps the greatest and most obvious advantage from the point of view of the public. It would certainly be extremely awkward if the newly purchased electric bulb would not go into the existing socket or the new tyre would refuse to fit on the wheel of the car.

2. It facilitates business transaction by enabling the buyer and the seller "to speak in the same language". This eliminates any risk of misunderstanding and is of mutual benefit to the consumer, the distributor, the manufacturer and the trade as a whole.

3. Standardisation warrants mass production and thus reduces costs to a considerable extent.

4. It is relatively safer for manufacturers to produce standardised goods (as opposed to goods not conforming to any standard specifications) even in slack periods, *i.e.*, even in the absence of any immediate demand. Thus standardisation indirectly stabilises production and employment.

5. Standardisation brings out the necessity of discovering new facts in order to determine what is best and also to provide the basis for the settlement of disputable questions. In this way it acts as a powerful stimulus to research and development.

National Standardisation Laboratories

It is therefore easy to understand why every civilised Government enacts laws and statutes for the

purpose of standardisation. The Governments also establish standardisation laboratories, the primary function of which is the establishment of standards and testing.

As such, these laboratories are responsible for the maintenance of and improving upon standards for all types of commodities which include scientific apparatus or instruments of the highest precision used in laboratories, as well as the development of the technique of measurement for accurately testing these commodities with reference to the existing standards.

In recent years the activities of these laboratories have expanded considerably in the direction of scientific and technical research. The laboratories carry out in close co-operation with the industries such fundamental investigations as may have long range application and serve as a vital link between scientific research on the one hand and industrial development on the other, their contributions to the advancement of purely scientific knowledge being no less important. Pre-eminent among these institutions are the National Physical Laboratory, England, National Bureau of Standards, Washington, U.S.A., Physikalisches Technische Reichanstalt, Germany and the Bureau de Poids et Mesures, France.

Accuracy of Standardisation

In the standardisation of ordinary consumers' goods the tolerances allowed may be relatively large. But in the case of industrial machinery or of scientific instruments used in laboratory work, the permissible tolerance is much smaller. In the standardisation of instruments of precision and research the tolerance allowed is a minimum. The precision demanded for this type of work implies that standards of the highest possible accuracy should be employed for such measurements. As already mentioned, it is one of the functions of the national standardisation laboratories to prepare such standards, to maintain them with scrupulous care and to constantly improve upon them..

It is therefore but natural that with the progress of industrialisation and the development of new branches of industry—which are more often than not interrelated with one another—the standard of accuracy should be continually rising. The increase of precision has been particularly marked in the measurement of electrical quantities. For instance, while in 1923, an accuracy of ± 1 in 10^4 was considered to be exceptional in the measurement of the frequency of electric oscillations, one is not content today with measuring the same even with an accuracy as high as ± 1 in 10^7. In fact, it is now possible to measure almost every electrical quantity with an accuracy of 1 part in a million or even more. In the case of frequencies, as noted above, the increase in precision has been particularly spectacular and at present frequencies can be standardised with an accuracy of one or two parts in 10^7.

The following remark of Dr H. L. Curtis, principal physicist at the Bureau of Standards of Washington, will bear quotation in this connection.

> "The discussion of the methods is based on the assumption that *an accuracy of one part in a million is desirable in every type of measurement.* This accuracy was selected as the most precise that was demanded in any electrical measurement. However, since the preparation of this manuscript was begun, there has been a pronounced increase in the precision of measurements in several fields. Comparisons of resistance standards are now made in one part in ten million, and the same can be said concerning standard cells. Standard frequencies are now disseminated which have this accuracy. The need for this extreme accuracy is exceptional but its use indicates the trend in electrical measurements and shows *that an accuracy of one part in a million should be the goal in most fields.* Moreover the use of the same standard of accuracy in all fields of electrical measurements greatly facilitates comparison between them[1] (italics ours)."

It is to be noted that this high precision is possible only in the measurement of an electrical quantity of a particular kind in terms of an accepted standard of the *same* kind. For instance, a resistance may be measured, in terms of a standard resistance, to an accuracy of a few parts in a million. The absolute value of the standard, however, may not be known with the same degree of accuracy. In fact, it is generally much less, being of the order of 1 in 10^5. The reason for this difference is not far to seek. Whereas, for example, for the comparison of a resistance with a standard resistance the simple bridge method with due precautions suffices, the technique of measuring the absolute value of the standard in terms of the fundamental mechanical units of mass, length and time involves complicated and elaborate methods which necessarily introduce relatively large uncertainty. In early measurements of the absolute value of the ohm, for instance, an accuracy greater than 1% could hardly be attained. In recent years, however, the accuracy has increased considerably and it has now been possible to establish the absolute value of the ohm with an accuracy of 1 in 10^5.

Accuracy of Modern Electrical Measurements

It should be clearly understood that by standardisation of an electrical quantity is meant the determination of its value relative to the established standard maintained in one or other of the national laboratories. We give below a brief account of the accuracies with which the important electrical

[1] Curtis, H. L., 'Electrical Measurements', McGraw-Hill Book Co., p. vii, 1937.

quantities—resistance, capacitance, inductance and frequency—can be measured at present.

Resistance.—It is relatively easy to measure resistances of intermediate values, *e.g.*, one ohm to one megohm, with an accuracy of one part in a million. This high accuracy can also be attained for very low resistances (down to 1/1000 ohms) if special precautions are taken[2]. We may quote here the following remarks of Dr L. Hartshorn of the National Physical Laboratory:

> "It is possible to make relative measurements of resistances to compare the resistances of Manganin coils with an accuracy better than 1 part per million and it will be found that recent reports of the International Committee of Weights and Measures give values of resistances to 0·1 part per million."[3]

The National Physical Laboratory of England can standardise resistances ranging in value from 1 ohm to 10 megohms with an accuracy of a few parts in a million. It may be pointed out that resistances of the order of 10^5 ohms and more are not sufficiently stable. In practice, therefore, such resistances are seldom required to be measured with the high accuracy mentioned above.

Standard resistances for use in laboratories for precision measurements can now be purchased from reputable firms with a guaranteed accuracy of the order of a few parts in a million.

Capacitance.—Capacitances can be measured in terms of standards with an accuracy of 1 part in 10,000 ± 0·01 micromicrofarad for values ranging from a fraction of a micromicrofarad to several microfarads. Astbury of the National Physical Laboratory in describing an equipment which provides a basis for capacitance standardisation in England writes:

> "The normal range of the bridge which is intended for frequencies below a few thousand cycles per second is from 1000 $\mu\mu$fd to 20 μfd. and over that range it is possible to obtain an accuracy of *2 or 3 parts in* 10^5."[4]

In discussing the accuracy attained in a typical measurement, Curtis says:

> "Under favourable conditions the uncertainty in a single measurement of a 0·25 μfd. air capacitor will not exceed *1 or 2 parts in a million*."[5]

Such extreme accuracy is perhaps not possible for capacitances of all values but it may be said that even the smallest practicable capacity can be measured correct to within 0·0001 $\mu\mu$fd, if not more. Astbury and Jones have developed a capacitance attenuator which can be applied to the measurement of very small capacitances. They say that this instrument can be applied to measure capacitances as small as 0·001 $\mu\mu$fd correct to within 0·0001 $\mu\mu$fd.

Capacitances can be standardised in the National Physical Laboratory with an accuracy of 1 in 10,000 ±0·05 $\mu\mu$fd. for values between 5 $\mu\mu$fd. and 10 μfd. at 1000 cycles per sec. It is understood that values up to 1000 μfd. can be measured with this accuracy but such high precision is not required in practice for these high values. Very low capacitances (*e.g.*, the inter-electrode capacities of thermionic valves) are measured even with greater accuracy, namely correct to 0·000001 $\mu\mu$fd.

Some well known instrument manufacturers also market accurate bridges which are capable of measuring capacitances ranging from 0·1 μfd. to 1000 $\mu\mu$fd. with an accuracy of 1 part in 1000. For measuring still smaller capacitances instruments are available in the market which claim to give values correct to 0·01 $\mu\mu$fd.

Inductance.—Inductances can also be measured with the same order of accuracy as capacitances at 1000 cycles per second.

In the National Physical Laboratory, inductances of values from 0·1 μh to 1 h are standardised with an accuracy of 1 in 10,000±0·05 μh at 1000 cycles per second. It is understood that values up to 1000 henrys can be measured with this order of accuracy but that is seldom required in practice.

In describing a method of measuring self-inductances, Curtis estimates that inductances as large as 0·1 h can be measured correct to 1 part in a million at a frequency of 150 cycles per second[6].

It is often necessary to measure inductances of smaller values at radio frequencies. Such measurements can be carried out in the National Physical Laboratory with an accuracy of 5 parts in 10,000± 0·05 μh though higher accuracies can be attained under favourable circumstances. The smallest inductances (a fraction of a microhenry to 1 micro-henry) can be measured with still higher accuracy *viz.*, to the nearest 0·001 μh at radio frequencies.

Precision Inductance Bridges available in the market can give an accuracy of 1 in 1000±0·1 μh in the range 1 μh to 100 h. The range can be extended to 1000 h but the accuracy for such high values is relatively smaller.

Frequency.—We have already mentioned that the accuracy of measuring the frequency of electric oscillations has increased tremendously in recent years. This has been largely due to the rapid development of broadcasting which demands the maintenance of the transmitter frequency constant to within the prescribed narrow limits.

[2] Curtis, H. L., *Ibid.*, p. 93.
[3] Hartshorn, L., *Reports on Progress in Physics* 5, 306, 1938.
[4] Astbury, *Report on Progress in Physics*, 6, 403, 1939.
[5] Curtis, H. L., *Ibid.*, p. 128.
[6] Curtis, H. L., *Ibid.*, p. 116.

At the National Physical Laboratory frequencies up to 30 mc/s can be standardised with an accuracy of 1 part in 10 million.

It is interesting to quote in this connection a remark made by Dr A. J. Gill in course of his address as Chairman of the Radio Section of the I.E.E. in 1939. In the words of Dr Gill

"Whereas the precision of measurement of $\pm$ 100 parts in 10^6 was exceptional in 1923, corresponding orders for 1928 and 1933 were $\pm$ 10 parts and $\pm$ 1 part in 10^6 respectively. To-day it is possible to measure to $\pm$ 1 part in 10^7 and in the near future it will be possible to work to $\pm$ 1 part in 10^8".[7]

In describing an equipment capable of measuring frequencies in the range 0 to 2000 mc/s. developed at the National Physical Laboratory, Mr L. Essen writes:

"Frequencies less than 30 mc/s. are compared directly with a signal obtained from oscillators controlled by the standard, and the accuracy of the measurement is limited only by that of the standard, which is $\pm$ 2 parts in 10^8, if the primary quartz clock at the National Physical Laboratory is used."[8]

The high accuracies in the modern measurements as described above, have been attained by taking the greatest precautions in the minutest details. For instance, in the measurement of a resistance an important source of error is the variation of temperature. All possible precautions are therefore taken to maintain every part of the standard resistance coil at the same temperature (by immersing it in an oil bath, for example, and keeping it constantly stirred) and noting the same accurately. The resistance of even a high quality standard coil changes by 20 parts in a million due to a change of 1°C. If the resistance is therefore to be measured correct to one part in a million the temperature is to be measured correct to within 1/20th of a degree centigrade. Again the sensitivity of the galvanometer must be such that it gives detectable indication for a change of resistance of the adjustable arm of one part in a million. Special attention is also paid to reduce contact resistances to a minimum. In the measurement of capacitances and inductances sufficient care is taken to minimise the stray capacitance of the leads and maintaining them constant throughout the experiment. Residual impedances of the bridge arms as well as the various connections forming the bridge circuit are taken account of in the calculations for accurate results. The alternating electromotive force impressed on the bridge is made as free from harmonics as possible. The detecting instrument is sensitive enough to indicate the smallest changes in the impedance of the adjustable arm. Further, special attention is paid to thorough shielding of the components wherever necessary in order to make the bridge balance sensibly independent of its surroundings, the position of the operator and also the type of generator and detector employed.

The author of this article, as Secretary of the Radio Research Committee of the Board of Scientific and Industrial Research, had been required to draw up a questionnaire regarding the availability or otherwise, in this country, of equipments and facilities for the standardisation of radio components and apparatus. In this connection he had to collect data regarding the present trend of accuracy of electrical measurements in modern Standardisation Laboratories. The present article is based on the information so collected and has been prepared at the request of the Chairman of the Radio Research Committee.*

[7] Gill, A. J., *Journ. I. E. E.*, **84**, 248, 1939.
[8] Essen, L., *Proc. Phys. Soc.*, **52**, 616, 1940.

* The author takes this opportunity of thanking the Chairman of the Radio Research Committee for helpful discussions and also the Director, Scientific and Industrial Research for granting permission to publish the article.

CORRELATIONS BETWEEN LINGUISTIC (CULTURAL) REGIONS AND THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON

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Introduction

THE great riddle of the world,—the Unity of Mankind,—will be solved by scientists, especially geographers, whose task it is to read the world as a whole with the lights of all other sciences focussed together; it is to discover the interaction of man and nature in its many aspects and to re-interpret it for the growth and development of human life and civilisation.

Similarly the riddle of India, the burning question of the day, *viz.*, the Unity of Communities, can be solved not by politicians but by geographers who will be called upon to re-interpret nature in the light of Indian history and to discover how the various communities, living in India, are formed and how the physical environment of rocks, soils, minerals, climate, water-supply, etc., has played its part in helping to produce different conditions and cultures in different physiographic regions.

Cultural Regions of India

Nature has made India a vast subcontinent, a conglomeration of many natural regions, many climates and many other physical stimulii for man to form convenient groups in different geographical surroundings. No wonder, then, that within its enormous area of nearly two million square miles, there live to-day almost four hundred million peoples of various castes and creeds, struggling to carve out their destiny under peculiar circumstances. And yet it is true that it is *an exceedingly good and suitable geographical unit* with enough geographical aloofness from the rest of Asia due to the great mountain barriers. It is capable of producing a single nation with one national goal of its own. It is true to say that from the points of view of external defence and internal management India is a natural unit. Well protected also by the seas in its coastal areas,—the country is singularly lucky to get opportunities to develop its own economic resources. Its good and perennial northern river systems have afforded very good settlements in the Indo-Gangetic plain formed by them, with their unifying influences and good neighbourliness created among those who managed to enter the region through the few but convenient mountain passes. Again, the numerous blocks of table-lands, in the Peninsular area, of volcanic rocks and igneous massifs, forested or unforested, have given the old classes of people, such as the aborigines and the Dravidians, good protection and shelter whereby they have been able to preserve their special cultures in wholesome climates within uncongenial latitudes. Thus, in India we have so many oases of culture, so to say, in a vast desert land, but their waters require to be mingled by a process of spiritual irrigation and assimilation in order to form an All-India Civilisation. If there is any country in the world most suited to the plan of unifying mankind, it is India.[1] Such a plan from the point of view of cultural regions has been projected in the present paper, keeping culture *apart from religion, provincialism* and *politics.*

Compounding of Indian Cultures

If cultures, instead of being made mere mechanical mixtures within unnatural and uncongenial political boundaries, are fused together as a real compound, they will be turned into one All-India civilisation, lasting for long epochs of time and benefiting all the communities, apart from their religious beliefs. Thus it is possible for all of us to live in India peacefully and progressively without interfering with our religious beliefs and without the unnatural methods of unification, such as intermarriages, conversions etc. If religion is kept apart from social life and politics, a certain amount of contact of cultures is bound to be healthy and fruitful "The establishment of contact between peoples with different training and equipment produces new ideas and liberates initiative".[2] The Parsees of Gujarat, for example, have rendered good services to India in this respect, without losing their identity for the last thirteen centuries (see my "Contribution of Gothic Culture to Indian Civilisation", Rathestar New Year Number 1941). The different modes of life, food and drink, industry, architecture, etc., all depend upon the environment found in the natural regions which are homogeneous in character and which afford a definite setting for man's life.

[1] T. N. Jagdisan- "Leaves from Indian Culture", 1943 (Blackie), Bombay, pp. 208 ff.

[2] J. H. Hutton Census of India, 1931, Vol. I, India, Pt. 1, p. 453.

Again, a true region has a speciality in production, trade, art, etc., based on its environs and resources. It is, therefore, absolutely necessary that there should be a proper scientific planning of daily life and its activities in all the cultural regions, so that each unit may give its share in the evolution of the whole country. Not only this, but there are other deeper and subtler uses of culture apart from religion. "That intermediate activity of humanity which lies between its religious function and its daily life,--the activity of culture, in which the glimpse and urge of a deeper life are expressed through the symbolism of the life that we know ; in literature which uses words and images drawn from daily life for the expression of a life beyond the day ; in the arts which have the sounds and colours of nature as means to the disclosure of a light that never was on sea or land."[3]

Such cultural activities of human beings in the different physiographic regions of our country are *truly Indian* in character, regardless of our religion or political and dynastic authorities. They provide stylistic evidences and nothing else.

Culture and Language

But the best and most useful product of a particular region is the *language* of the people living in it, again irrespective of their castes or creeds. "Culture is fine but certainly not great enough till it has found means to translate itself to the language of the masses of the people and reach down to their understanding and at the same time keep itself vigilantly engaged in upholding its true nature. For, even in order that a few should be enlightened, the many must be persuaded to prefer light to darkness."[4] It is true that words are excellent carriers of culture in whichever region it thrives and language is a rich storehouse of ideas and ideals of man. It is the proper expression of the physical conditions, the raw materials, their uses and by-products. Men really think in terms of these and clothe their thoughts in suitable words. It is equally true to say that a certain region gives rise to a certain vocabulary and a certain kind of people produces a certain kind of literature. It is, therefore, said that the mother tongue is the best for expressing our thoughts and therefore the most precious asset of a class of people. Our language has definitely close connections with our history, habits and aspirations. It is decidedly the most powerful instrument for the unification of different groups living in the same region, as it is a symbol of unity, the tongue of the hearth and not of the market place.

The better the race, the more powerful is the medium of expression and the more dominant the language and literature produced by it. Nearly 75% of the people living in India speak the Indo-Aryan languages, which shows that the Aryans have left their most indelible mark upon them. "The most important and the lasting gift of the Aryans in India was probably their language,—a vehicle of communication and expression belonging to a family of languages which has produced its superiority in all parts of the world by superseding any other languages with which any of its members have come into effective competition."[5]

It is no wonder, then, that this Indo-European group of languages has pushed out the ancient Dravidian languages into the remotest and least fruitful parts of the Peninsula and even of Ceylon. Not only this but there has also been such a severe mingling of these cultures in some convenient parts of the country such as the fertile river valleys that it is difficult at times to define exactly the areas occupied by the peoples and to point out the stages at which a transformation is taking place in the physical characteristics and the linguistic peculiarities of the peoples.

Regional Languages of India

In such an enormous land mass, in which there are so many and such varied physical environments, where there has been an influx of so many classes of people from time to time and where so many kingdoms and empires have come and gone, it is but natural that there are over 175 different languages with more than 500 dialects spoken by the people in different parts, so much so that in Marathi there is a regular proverb : "Speech changes within a distance of one-hundred miles". About 50 of these languages are spoken by less than 1,000 persons and so are unimportant. The dominant languages, which are taken by me as regional, are 23. Unfortunately for us, these linguistic regions do not coincide with the political divisions of the country. But on the other hand, there are *some marked correlations between them and the natural divisions.* India is most unnaturally divided to-day into some 11 provinces including the Native States, which are again subdivided, without any sound principle, into divisional circles and districts, so that in a particular presidency such as Bombay or Bengal, there are half a dozen principal languages spoken by the people, who therefore cry for the separation of more and more provinces. This is the root cause of all the troubles

[3] James Cousins—"The Cultural Unity of Asia", Adyar, 1922, p. 4.

[4] A. C. Bose—"Culture and Mass Religion", *Mod. Rev.*, Sept. 1941, p. 239.

[5] J. H. Hutton—*op. cit.*, p. 369.

in our country. There is not one language which is the real carrier of culture to unify these unnatural political divisions, of which the boundaries are so haphazardly made. Their peculiar sizes and shapes are due to strange historical circumstances and chance treaties. Because a Bombay army had to conquer Sind on their way to the Punjab and Afghanistan, Sind remained annexed as an appendage of no great importance to the Bombay Presidency for well-nigh 100 years. Its separation in 1936 was therefore most welcome, as it is a natural division falling within the limits of the Lower Indus Basin (see my "*Geography as an aid to the unification of Indian Culture*", *Ind. Geog. Journal*, December 1941).

Political Boundaries—The Hindrance

These political provinces have made the peoples, living within their limits, think in terms of party politics and not of real culture. They have created much provincialism, unworthy of a great country. Under provincial autonomy, recently granted by the British rulers, the situation has grown worse and the essential unity of India is fast breaking up. The cleavage between several Indian provinces, *e.g.*, Bihar and Bengal, Sind and the Punjab, Ceylon and South India, is really due to these artificial political barriers and rugged provincial boundaries. There is no inter-provincial exchange of cultures, crops, etc., on the same account.

Redrawing of the Map of India

What then, is the remedy? Since India is such a large sub-continent with different physiographic features, a re-division of it on a really cultural basis should be made with a provision for a re-union of them with convenient lines of communication and for a regrafting of them with common natural ideals under a benign and representative Central Government. In other words, if India is to be divided for its efficient administration and maximum benefit of the people, its best divisions should be *physiographic with natural boundaries and congenial environmental inflences for their growth and evolution.*

Physiographic Divisions—The Basis

For the solution of this most vital problem of India's cultural unity, the first thing to do is to break the political barriers and to set up natural physiographic boundaries. This will stimulate the cultural process considerably, as its administration will also be more effective. For this purpose, the author has already presented his scheme of Physiographic Divisions of the country, commenting upon which he expressed the hope that they would probably coincide with its Cultural Regions:

"These regions will greatly facilitate the programme of national planning in India and will conduce to the harmony and prosperity of the various peoples without losing their individuality on account of their congenial environment and to the evolution of an all-India civilisation, which is our need today."* This hope is fortunately realised to a great extent.

In the map drawn for the present paper, an attempt has been made to show the correlations between these physiographic divisions and the linguistic regions, taking the latter to be *representative of the cultural regions*, as shown above (see the Map showing the regions). A region has been considered by me to be belonging to a particular culture, if the majority of the people, say 60% living in it, speak the *dominant language* which is representative of that culture. To a certain extent, this linguistic map coincides with the ethnological one.

As India is physically divided into three main divisions, the Extra-Peninsular Mountains, the Indo-Gangetic Plain and the Peninsular area, its main cultural groups also coincide with them nearly. The Pahari group rests largely on the Himalayan mountains, with the Pushto-Lahnda (Indo-Iranian) bordering on its western flanks and the Tibeto-Chinese on its eastern flanks. This high-mountain culture is still exclusive and segregated from the valleys lower down, though it is affected by the neighbouring Tibetan and Iranian plateaus. It harbours a warlike race of itself with runaways from plains below and from the Iran plateau through the convenient passes on one side and immigrants from the Chinese river valleys on the other five main languages are spoken in these parts.

The Indo-Aryan family, in which are included no less than 11 prominent languages, has taken full possession of the Indo-Gangetic Plains and has also penerated a large part of the Peninsula owing to its superior culture, thus occupying more than half of the country. Here and there on the plateau there are a few "islands" of aboriginals speaking prominent languages, *e.g.*, Munda and Bhili, segregated in forested areas ; but in the fertile valley with good water supply and food plains there has been a definite absorption of ancient cults and a proper intermingling of the Indo-Aryans with the inner (Madhya Desa) belt of important languages and the outer belts or others (outer belt). The sea has begun to affect the coasts decidedly in recent years. The third Dravidian group, which has been driven as far away as possible by the invading Aryans, nearly coincides with the old Archaean block including Ceylon. Poor

* Ref. my "Physiographic Divisions of India, Burma and Ceylon", SCIENCE AND CULTURE, 7, 537 ff, 1941-42.

rocky soils, rain-shadow areas and tropical heat have imposed many vicissitudes of life on these people, yet they harbour a very high degree of old culture comparable with the Aryan civilisation which has lisation.[7] It must be noted that in every natural region in which a particular group of people lives, the physical environment *does not remain the same.* Scientists have proved that everything on the earth

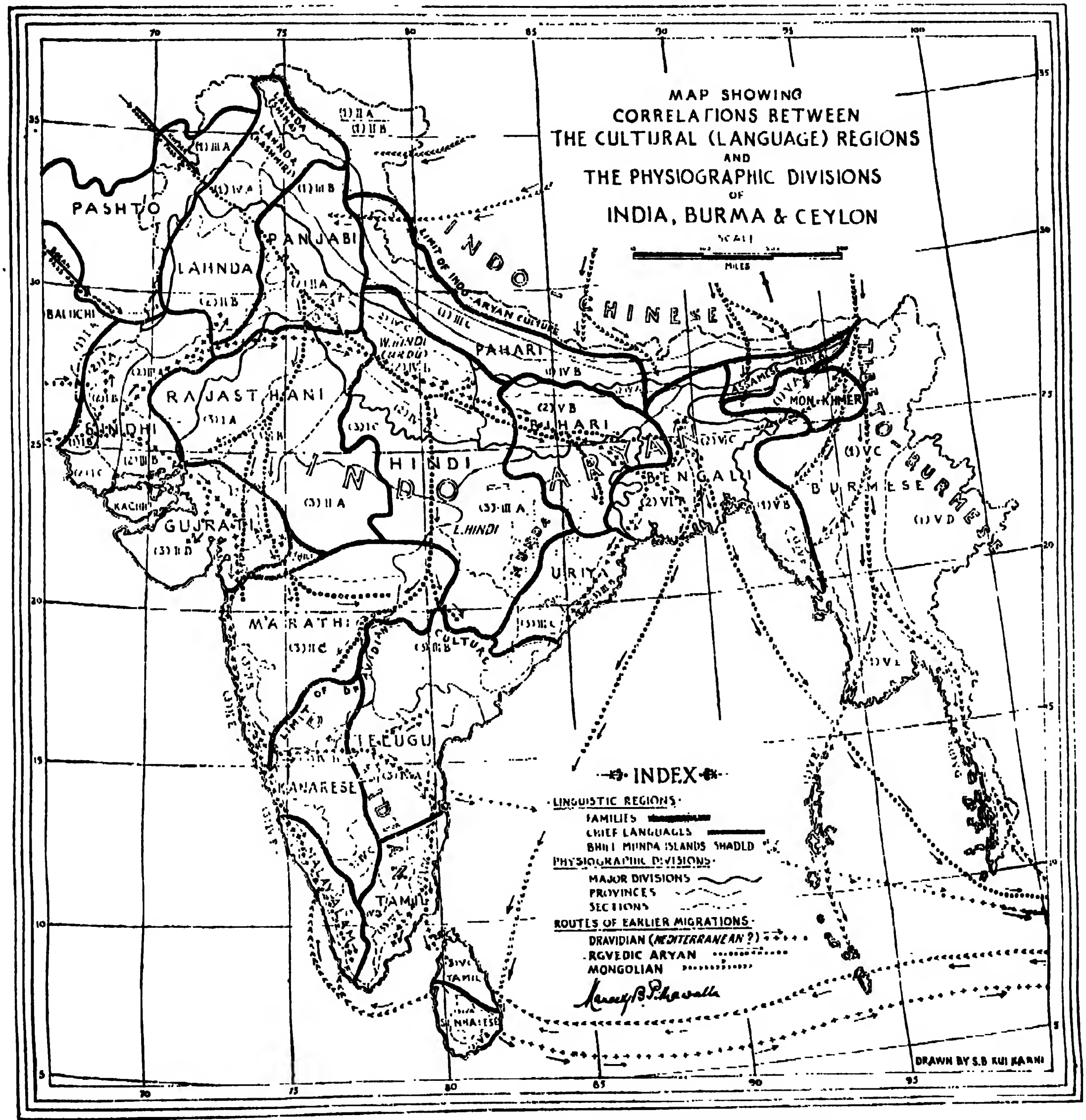

FIG. 1. Map showing Linguistic and Physiographic Divisions.

displaced it from Hindustan proper. There are five of these Dravidian languages evolved by this race in South India and Ceylon.

Physical Environment Changes

It is a mistake to suppose that physical environment is only static and cannot create a lasting civi- is changing,—land masses, seas, lakes, river courses, desert areas,—all are inconstant ; even the axis of the earth and with it the climates are changing, as has been proved by the presence of tropical coal seams in the polar region. Nature is not static but is dynamic and man therefore gets varying oppor-

[7] R. K. Das—"Civilisation", *Mod. Rev.*, July 1941, p. 36.

tunities to evolve himself on the globe. Man can control nature but there is a certain limit to this. Hence the only chance of unifying all the regions permanently rests with man.

Process of Cultural Evolution

A study of the regions shown in the Map, reveals some of the following definite phases of cultural evolution:

1. *Mingling of Cultures*: This process is prominent in the Indus Valley (Sindhi and the Punjabi), the whole Ganges Valley (Hindi, Bihari, Bengali), Central India Tableland (Hindi and Rajasthani), Golconda Coastlands (Oriya, Munda and Telugu) and Malabar Coast (Malayalam and Tamil).

2. *Stabilisation of Cultures*: The process of acculturation is more or less stable though not without an overflow in the following regions:—

Rajputana Uplands (Rajasthani), Western Peneplains (Cutch, Kathiawar and Gujarat), Western Ghats, Bombay Deccan and Konkan (Marathi), Nilgili Hills and Bellary Section (Kanarese), Caddapah Section (Telugu), Tamil Sections (Tamil) and S. W. Westlands of Ceylon (Sinhalese).

3. *Isolation of Cultures*: Cultures, whether aboriginal or native, are completely isolated in the forested areas of the Mahanadi Basin and Chota Nagpur area (Munda), Central India Tableland (Bhili and Gond), Nilgiri Hills (Todas), Shillong Plateau, Khasi Hills (Naga) and Central Massif of Ceylon (Veddah). There is, however, a slow but steady absorption of these by the more powerful cultures which surround these isolated groups of ancient cults in the whole country, *e.g.*, Bhili into Gujarati and Rajasthani, Munda into Hindi and Oriya, etc.

4. *Migration of Cultures*: As stated above, the Indo-Aryan languages have penetrated far into the Peninsular area as far south as possible, displacing the original languages through the efforts of successive hordes of invaders. Migration is definite in so far as the cultures are dynamic and the lines of communication possible, though not easy. Even the sea is not the limit, as India's Culture has greatly influenced Greater India, including Java and Sumatra[8] and also China, Korea and Japan.[9]

The Dravidian languages have duly crossed the Gulf of Manar for Ceylon and the ocean further south for Australia, proving thereby that this pre-Aryan culture is not quite static, though not as powerful as its original rival.

While natural channels, such as a perennial river system, are the best means for carrying and spreading the various cultures and deserts or mountain systems the worst obstacle for them, any artificial stimulants also work wonders.

Examination of Natural and Artificial Stimuli

The best example is that of the carriage of Marathi culture from its elevated position on the Deccan Plateau to the low coastland of Konkan by a railway route through the Western Mountain barrier, allowing an exchange of men and materials through the Bhor Ghat. A telling evidence of this is found in the inscription of the railway bridge constructed by Captain Hughes in 1830: "During the administration of Major General the Hon'ble Sir John Malcolm, G.C.B. anno domini 1830 the road on this ghat was constructed, which by rendering the transit of merchandise on wheeled carriages available and thereby facilitating an intercourse between the Deccan and the Konkan, secures to the country permanent and solid advantages." The greatest advantage of this, no doubt, was the transference and interchange of cultures, as the linguistic map of the region shows.

At the same time, any artificial barrier, such as the political boundaries of a British territory or a Native State, does not prevent cultures from mingling. A very good instance of this, is the Deccan Hyderabad State, the population of which is drawn from three or four cultural regions, *viz.*, Marathi, Kanarese, Telugu and Hindi, the first being the most dominant. An attempt to enforce the State language, *viz.*, Urdu, upon the populace is futile, as the avowed medium of instruction in the Osmania University is "the language of the court but not of the hearth". Nearly 90% of the people belonging to the Hyderabad State speak Marathi, while only 10% speak Urdu, which is really speaking a foreign language for the masses. "The Maharashtra of Godavari Valley (Paitha) was the prestine Maharashtra and is entitled to be in touch with the Modern Maharashtra of the Krishna (Wai). The real mother tongue is the only language through which we imbibe our culture and natural nationality."[10] Indeed Marathi cannot be suppressed by Urdu in this region in this manner.

Again a reshuffling of the population of the political divisions, as was attempted by the dictators of Europe, will fail to solve the problem of the Unity of India. It is not within the bounds of practical politics in any country. Nature must be allowed to do its work as best as she can ; but at the same time

[8] Kalidas Nag—"India and the Pacific World", Calcutta, 1941.

[9] James Cousins—"The Cultural Unity of Asia", Adyar. 1922, p. 31 ff.

[10] N. C. Kelkar—"Hyderabad Education Policy"—*The Progress of Education*, Vol. XX, Oct. 1943, pp. 72-73.

man can help by offering some artificial stimulii, such as roads, railways, schools and colleges and Universities, planned on an all-India basis. The old system of pilgrimages to certain special shrines and temples, situated in different regions of India and playing a certain part in awakening the geographical consciousness of India, as a whole, should be revived. "What contributes towards making a nation is not only a common language, religion, government or culture, but the evolution of a common country, a common fatherland."[11]

Besides, any new settlements that may be established in India should not be unnaturally based on religious denominations and according to the present provincial interests but on the *common natural* advantages, such as the utilisation of fertile lands, canal waters, rocks or minerals as well as on the common disadvantages such as floods, famines, diseases, etc. This co-operative spirit is still dominant in our villages, but not in the urban centres due to foreign education. It is clear that the level of culture among the vast bulk of our rural population is fairly uniform and that divergence in the religious beliefs does not affect the neighbouring feeling existing among the people. *"The villages still retain some semblance of a well-balanced self-sufficing economic unity."*[12]

The Question of a *Lingua Franca*

One more question in connection with the problem of the unification of cultures remains to be solved, *viz.*, a *lingua franca* for India. Often in recent years a claim for Hindustani has been put forward that it is and can be widely understood by people in all parts of India. A common language is, by all means, the most unifying factor in national planning. U. S. A. has done it for long. Now we have already noticed that if there is any language that is most widely diffused, it is Hindi, both eastern and western. It covers naturally a big territory belonging to Section (2) IV A, B, C, D, (3) I C and (3) III A. It is still spreading wider, and yet there are many difficulties of making it a *lingua franca* of India at present:

1. There is the question of the script, neither Persian nor Sanskrit can be accepted; it must be Romanised, as is done in Turkey.

2. The bulk of the rural population in India speaks its own original language and Hindi is not even known to them, *e.g.*, people living in the Dravidian regions are quite ignorant of this medium. A simplified form of Hindi or Hindustani will have to be introduced in all our primary schools in the first place.

3. Hindustani cannot boast of any great literature and as such it cannot be accepted by the educated classes as a medium of expression. It would take long for it to evolve to a high literary stage. Other Indian languages such as Bengali and even Telugu have excellent literatures of their own and would not readily yield to such a language of the market. The late Professor P. Seshadri has wisely opined "To put the matter plainly, the *question of lingua franca should wait* for an exhibition of literary superiority by Hindustani which will sweep people off their feet and recognise high realm of beauty and genius."

However, as the Map shows clearly, Hindustani has a very great future in India for a common Indian language. Its vocabulary, as enriched from both Hindu and Islamic sources, will grow and will be acceptable to both the major communities. There is no compulsion in the choice of words used by any party. It is successfully handled by the elite of both the classes of people and well accommodated in writing to Urdu or Nagri scripts for the national evolution of a common Indian vernacular.

All-India Civilisation

How, then, will it be possible for us to evolve an *Indian civilisation in the near future*? Our only hope is to harmonise the different cultures under the guidance of a wise Central Government and to produce one All-India Culture by mutual understanding and good will. Not by dividing and re-dividing the country *unnaturally*, not by enforcing any *foreign* language or culture on the masses of India and not by any *unnatural* social methods, shall we be able to unite all the communities and form one united nation with common ideals and aspirations. One culture should not be allowed to suppress another. A free hand and equal opportunities should be given to all the different cultures to satisfy the *needs of all* who live in the country. In a land saturated with pantheistic ideas, these cultures are like the immortal souls dwelling in the body forming its total civilisation. To make this body last long, there should be harmony and health of the organs of which it consists. Thus if we want India again to be proud of a great civilisation in the modern world, it must be re-integrated and re-souled by the cultures of all the classes of people, on the basis of national planning. These are:

1. Revival of all forgotten or forsaken contacts by a process of cultural irrigation;

[11] Radhakumud Mookerjee—"Nationalism in Hindu Culture", London, 1921, p. 49.
[12] Sir Jogendra Singh—"The Cultural Problem", Oxford Pamphlet No. 1, 1942, p. 54.

2. Utilisation of nature and her resources as best as we can without regard to political boundaries or communal interests ;
3. Collection of moral and spiritual forces inherent in the different races, without disturbing their religious susceptibilities ;
4. Development of a common language like Hindustani, by mutual co-operation, with a common script and by a national system of education from the primary stage and organisation of Literary Leagues on a *linguistic* basis throughout the country ; and
5. Appeal to the Inter-University Board to co-ordinate the scientific work done in all Indian Universities, particularly geographical researches. The most urgent work to be done is that of preparing the *Geography of India based upon the regional geographies of the 23 physiographic-cum-cultural regions* shown in the Map.

Conclusion

If the linguistic map of the country is superposed on the physiographic map, we notice that there are some marked coincidences between the cultural regions represented by the vernaculars and the physiographic divisions previously drawn and that, except in a few regions, cultures have constantly moved inside and outside their boundaries, *though they were born of the geographical environment found within the limits of the divisions.* In some cases they have even migrated to distant parts along certain natural channels, such as river valleys or seas. There are, no doubt, certain outer bands or fringes of the regions which cannot be defined from the point of view of a dominant language or culture. They can be called neutral bands or no-man's lands. The most prominent region, however, *viz.* that of Hindi, is most widely spread in India, having absorbed many foreign elements. This is the heart of Indian national culture, already an inseparable *compound* of Hindu and Muslim cultures ; it has been beating forcefully and, if nature is not unduly disturbed here but helped by man, the life blood from the region will flow fast and far and mingle at no very distant date, into an Indian National Civilisation, provided we put into action a first-class nation building programme at all the Indian Universities.

Not only this, but such a unified Indian Civilisation is likely to influence the outer world as well. "The genius of the Indian nation is a vast presence which transcends the actual physical or geographical embodiment and in its ideal possibilities can indeed embrace the whole world of man. Thus the evolution of India as the mother-country of the Indians has but followed the lines of the cosmic process revealing the Universe in the Particular and the Particular in the Universe. Here is no insular culture lacking in universality, nor a dismembered one which is homeless and therefore infructuous and sterile."[13]

But even if we do not aspire so high, we can but hope for complete fruition at home. And so the Indian nation can be likened to the age-old Banyan tree, whose massive trunk has taken deep roots into the rich soil of the mother earth and whose larger branches and smaller twigs are the different communities and creeds, still clinging in a congenial atmosphere, to their kith and kin, and from whose sides again descend the hanging roots all anxious to meet the mother, who gave them birth, once more. May it flourish for ever long !

[13] Radhakumud Mookerjee 'Nationalism in Hindu Culture", *Op. cit.*, pp. 98-99.

TABLE SHOWING CORRELATIONS BETWEEN LINGUISTIC (CULTURAL) REGIONS AND PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON

(Ref.: "Science and Culture", 7, 538-543, 1940-'41)

Linguistic (Cultural) Region	Physiographic Divisions covered.	Brief Notes on Characteristics, Environmental influences, Cultural traits, etc.
	I. Extra Peninsular Mountains.	
1. Sindhi	(1) A Kirthar Mountains .. (1) B Kohistan Section .. (2) A Indus Western Valley (2) B Indus Eastern Valley (1) C Indus Deltaic Area (2) III A Pat Section (2) III B Thar Section	One of the best regions for a mingling of cultures. Entry into the Valley by some 16 different peoples by land and sea. Partial desert land made habitable by man with the help of a perennial river. The human factor active in annihilating Nature's calamities *e.g.*, Ancient irrigation system. Cradle of the Mohenjo Daro or Indus Valley Civilisation (Dravidian ?). Destruction of the civilisation by natural catastrophies, such as floods, river changes, and by Aryan and other invasions from Iran plateau etc. Language mixture of Arabic and Sanskrit. Home of Sufism. (For further details, see my "Geography and Culture," Karachi 1942).

LINGUISTIC (CULTURAL) REGIONS AND PHYSIOGRAPHIC DIVISIONS—*Contd.*

Linguistic (Cultural) Region	Physiographic Divisions covered	Brief Notes on Charasteristics, Environmental influences, Cultural traits, etc.
2. Pashto	(1) III A N. W. Dry Lands (2) II B Punjab Plain (1) IV A Potwar Section	Influenced by Afghan borderlands and fringing the western parts of the Punjabi belt. Superseding also the language of Swat and higher reaches of the Indus as a *lingua franca* here. Gandhara sculptural relics and also Greek relics found.
3. Pahari	(1) II A North Himalayas (1) II B South Himalayas (1) III C Lesser Himalayas (1) IV B Sub-Himalayas	Mountainous region from Chamba to Nepal, harbouring a special culture, as an excellent example of isolation in the highlands but covering vast areas. Culture derived from Iranian on the one hand and Indian such as Rajput from Rajasthani in the low lands, a sort of transplantation. Specialised in the Sub-Sections *e.g.*, Naipali, that is New Pali. Warlike peoples with martial traits.
4. Kashmiri ..	(1) III B Dun Section	Specialised Pahari tongue in one Dun and isolated in the Upper Jhelum Valley. Special Dun culture, developed on independent lines by a colony of the Punjabis. Bulk of the population Moslem but ancient Hindu (Gandharva) relics are found here. Excellent climate and beautiful nature scenery, inspiring the people to produce various arts and crafts from olden times.
5. Mon-Khmer	(1) V A Shillong Plateau	An instance of Indo-Chinese influences on the eastern frontier of India, like Pushto on the western borderland. An island among Tibeto-Burman languages but correlated to Burmese. Recognised as an Indian vernacular by the Calcutta University.
6. Burmese ..	(1) V A Shillong Plateau (1) V B The Burmese Yomas (1) V C Irrawadi Valley (1) V D Shan Plateau (1) V E Irrawadi Valley (1) V F Kaladan Valley (1) V G Salween Basin, Burma	A singular instance of assimilation of Tibeto-Burmese Culture such a vast scale. Has spread to the North-South valleys of Burma's great rivers. People of Mongholian origin, resourceful and hard-working. Has migrated to Andaman (Andamanese) and Nicobar (Nicobarese) islands in the south.

2. Indo-Gangetic Plain.

Linguistic (Cultural) Region	Physiographic Divisions covered	Brief Notes on Charasteristics, Environmental influences, Cultural traits, etc.
7. Lhanda	(1) III B Dun Section (1) IV A Potwar Section (2) II B Punjab Proper	A casteless region. Infiltration of Persian elements into western Punjab. 74°E Longitude is considered to be the dividing line. Hilly influences give rise to Sub-Sections, *e.g.* Lhanda Shina and Lhanda Kashmiri in convenient plains. Buddhist, Persian and Hellenistic influences.
8. Punjabi	(1) III B Dun Section (2) II A Doab Section (2) IV A Indo-Gangetic Watershed	Intermediate between Lhanda and Hindi. Several tribes are absorbed here. Has produced a virile and warlike race. No caste restrictions due to Mahomedan predominance. Special caste of Sikhs evolved, a mixture of Islamic and Hindu cultures. Good soil and crops in all the Doabs. Good nourishment. Mughal art and architecture prominent with Indo-Saracenic influence.
9. Hindi	(2) IV B Jumna-Ganges Doab (2) IV C Piedmont Zone (2) IV D Trans-Jumna Tract (3) I C S.E. Rajputana Section (3) II A Central India Tableland (3) III A Mahanadi Basin (3) III B Godavari Basin	Most important of all Indian cultural regions. An intermixture of Indo-Aryans and Dravidians. Most widely spoken language in India, with the Upper Ganges valley as its home. Mingling of cultures exceptional. Cradle also of Buddhism and Gupta arts. Even the Peninsular area and Central India Tableland penetrated through the river channels of the Chambal, the Betwa etc. Tribal cults absorbed. Influenced by Arab or Persian Mahomedans in the west (western Hindi or Urdu developed) and by Aryan Hindus in the south east (eastern Hindi developed). Even architecture is influenced by Moslem and Hindu art. Indo-Saracenic culture. Meeting Marathi further south and giving rise to a number of dialects. People have a traditional knowledge of agriculture and have a high sense of duty and hospitality as the culture is cosmopolitan and dynamic. Hindustani offshoot a promising *lingua franca* of India.
10. Bihari	(2) V A Bhangar Section (2) V B Khadar Section (2) III A Mahanadi Basin	Belongs to the middle Ganges Basin chiefly. Intermediate between Hindi and Bengali. Covers also Oudh, Baghelkhand, Chatisgarh etc. Offshoot Ardhamagadhi, the language of Indian epic poetry. Centre of great religious movements. Sacred Ganga (Ganges) cult and land of many saints. Stronger and more hard-working race than those of the Lower Ganges Basin. Valuable coal and iron mines find suitable labourers.

LINGUISTIC (CULTURAL) REGIONS AND PHYSIOGRAPHIC DIVISIONS—*Contd.*

Linguistic (Cultural) Region	Physiographic Divisions covered	Brief Notes on Charasteristics, Environmental influences, Cultural traits, etc.
11. Bengali	(2) VI B Old Ganges Delta (2) VI C New Ganges Delta (1) V B The Yomas (1) V F Kuladam Valley	Another excellent delta culture. A blending of Dravidian, Mongoloid and Aryan elements. Resembles Sindhi on the other side of the country. Excellent tongue and literature developed. Situated in the most thickly populated part of India and therefore there are the greatest numbers of speakers. Early English influence at the time of the East India Company. Missionary work done. Even the Bengali language is affected by them, though the literary form is Sanskritised. Special types developed in Sub-Sections of Burmese Yomas and the Arakan Coastland. Delta people with little energy in an enervating climate.
12. Assamese	(2) VI A Lower Brahmaputra Valley	Belt between Assam on one side and the Himalayan slopes on the other. Good seclusion in the narrow Lower Brahmaputra valley parts and therefore command a special language and literature. Naturally free from Sanskrit traits, though related to Bengali, due to its aloofness.
13. Rajasthani	(3) I A N.W. Rajputana (3) I B Marwar Peneplain (3) II A C. I. Tableland	Powerful influence in the dry uplands. Flow of the midland races passing through Rajputana belt to the sea in Gujarat. Even Buddhistic contact, *e.g.*, Sanchi. Many tribes and their dialects meet here. Jaina Brahmanical art developed. Safe from the dread of the attacks from rulers in the plains in the north. Castes (tribal) superiority preserved in some States. Some migration to the northern mountains.
14. Gujarati	(3) IX D Western Peneplain	Showing the cultural unity of Gujarat proper, Kathiawar and Cutch. Cutchi dialect is affected by Sindhi while Marwari just enters Gujarat in the north. Can be styled the most westerly branch of the Indo-Aryan tongues, reaching the sea board for further contacts by sea. Jain influences. Contains many other relics of old. A soft people belonging to soft soil. Have often suffered due to famines. Good traders due to sea ports, through which also Zoroastrian culture has entered.
15. Marathi	(3) II A Central India Tableland (3) II B Western Ghats (3) II C Bombay Deccan (3) II E Konkan Coastland (3) III B Godavari Basin	Very dominant plateau culture for at least 1000 years on Deccan Trap region. Remarkable coincidence of Trap rock and Marathi. Rich regur (black cotton) soil and cultivable valleys, though parts suffer from rainshadow and famines. Underground passage and hill fortresses possible due to the peculiar structure and denudation of the rock. Has affected the Konkan coast due to artificial line of communication and penetrated Berar through river valleys and the Nizam State and merges into Oriya. Has contacted Gujarati (another denuded Trap soil culture) and developed Khandeshi. Also absorbed tribal languages *e.g.*, Gondi and pushed back Kanarese in the south. Unaffected by Islamic culture. Excellent literature of a spiritual character. Warlike as well as saintly character of the people, fond of music and other arts. Wonderful caves cut in the dykes etc. Scytho-Dravidian traits in Maratha Brahmans.
16. Oriya	(3) III C Eastern Ghats (3) III D Golconda Coastland	Isolated Munda-type, unchanged for centuries. Good literature. People live a life of struggle against natural handicaps.
17. Munda	(3) III A Mahanadi Basin	Forests of Chota Nagpur, its principal home. Relations with further Indian cults, such as Nicobar. Small "islands" persisting still in other parts of India. Probably aboriginal.
18. Bhili	(3) II A C. I. Tableland	An "island" of aboriginal culture, secluded in forest areas of the Sathuras.

3. The Peninsular Area.

19. Telegu	(3) III B Golconda Coastland (3) III C Eastern Ghats (3) IV A Cuddapah Section (3) IV G Coromandal Coastland	Offshoot of Dravidian Culture still persisting in the north of Madras Presidency and the Andhras. Special character evolved locally. Poor people living on scanty rice food, meat and fish. Little cultivation due to poor rainfall and Archaean rock soil.

LINGUISTIC (CULTURAL) REGIONS AND PHYSIOGRAPHIC DIVISIONS—*Contd.*

Linguistic (Cultural) Region	Physiographic Divisions covered	Brief Notes on Charasteristics, Environmental influences, Cultural traits, etc.
20. Tamil ..	(3) IV D Tamil Section (3) IV E Eastern Slopes (3) IV G Coromandal Coastland (3) V C N-N.E. Drylands (Ceylon)	Has preserved what is best in the Dravidians, since it is driven to the furthest south. A most highly developed language with extensive literature. Frugal habits of the people. Influence of double monsoon. Northern parts of Ceylon inhabited by Tamil folk living a hard life in drier areas, proving that from the point of view of culture as of rocks, Ceylon is an integral part of India. Conflict with the Sinhalese, still further south in the island.
21. Kanarese ..	(3) II C Bombay Deccan (3) IV B Bellary Section (3) IV C Nilgiri Hills	Chiefly confined to the Mysore plateau and the rainshadow parts of the Western Ghats. Land rich in minerals of the Dharwar rocks, excellent waterfalls for producing electric energy. An advanced Native State. Relics of ancient Hindu art. Very old literature preserved.
22. Malayalam	(3) IV C Nilgiri Hills (3) IV D Tamil Section (3) IV F Malabar Coastlands	A modern dialect of Tamil but confined to the East (Malabar) coast. Difference due to foreign influences by sea and through the Palghat Gap. Hence half a dozen dialects within a couple of hundred miles. Cochin murals a prominent art.
23. Sinhalese ..	(3) V A Central Massif (Ceylon) (3) V B S.W. Wet Lowlands (Ceylon)	The only other language found in Ceylon and yet belonging to the Indo-Aryan group. Furthermost offshoot of the culture of the ancient peoples with Veddahs living as a separate colony of aboriginals within the Binthana forest belt. Influence of Buddhism so far. Mingling has taken place between the Tamils and Sinhalese in the island. An Aryan migration from the Ganges Basin to Ceylon, with Sanskrit and Pali culture, pressed down by the old Tamil folk from the northern drier parts and now occupying nearly three-fourths (S.W.) of the island, with gems and graphite mines, rubber and tea plantations and paddy fields. A thin rural population of Buddhists, rich due to the riches of the island and high-class but more luxurious and backward than the hard pressed Tamils in the north. Rejuvenation of the rivers of Ceylon must keep the people and their culture ever alive.

SUMMARY OF THE TABLE.

Major Physiographic Division	Provinces and Sections covered	Number of Cultural Regions affected
(1) The Extra Peninsular Mountains	21	6
(2) The Indo-Gangetic Plain	22	12
(3) The Peninsular Area	27	5
Total (3)	Total 70	Total 23

ASTRONOMICAL WORKS OF MAHARAJA SAWAI JAI SINGHJI

B. N. TEMANI

ACCORDING to Garrett, of the five observatories constructed by Maharaja Sawai Jai Singh—the one at Delhi was built first of all in 1724 A.D., the largest and the most perfect was built at Jaipur in 1734, while those at Benaras, Ujjain and Muttra were built afterwards.

On the refusal of Farrukhsiyar to accept his help, Jai Singhji appears to have returned to his capital and to have enjoyed three years of uninterrupted quiet. He took no part in the subsequent struggles for the throne of Delhi which terminated in 1721 with the destruction of Syeds and the accession of Muhammad Shah. During this period and afterwards Jai Singhji devoted himself to his favourite pursuits, astronomy and history, and built his observatories at Delhi, Jaipur, Ujjain, Benaras and Muttra, but very early in Mohammad Shah's reign he was appointed Governor of the provinces of Agra and Malwa. So highly was his learning and science esteemed, that Muhammad Shah especially appointed him to reform the Calendar and to make observations to correct the astronomical tables in use. After seven years' work, Jai Singhji brought out, and in 1723 published, his tables, the "Zeech Muhammad Shahi" named after the Emperor Muhammad Shah. One manuscript copy of it is in Pothikhana, Jaipur, and a complete Persian manuscript copy is at the British Museum.

Jai Singhji appointed Samrat Jagannath a Maratha Brahmin, who was one of his most eminent astronomers—as his Guru. The book *'Samrat Siddhanta'* was written by him. He also had a good knowledge of Arabic and could translate from, and into Arabic. He translated Claudius Ptolemy's *'syntaxis'* (astronomical treatise) from its Arabic version known as *'Almajista'* into Sanskrit. This book is called *'Siddhanta Sara Kaustubh'*, and is available in Pothikhana. He also translated the whole of Euclid's *'Elements of Geometry'* from Arabic into Sanskrit. It was named *'Rekha Ganit'*. It is also available in Pothikhana.

Samrat Jagannath was the son of Ganesh and grandson of Vithal. He got village Manga-Bhata for Rs. 2,000/- per annum as Dakshina on account of his teaching Gayatri Mantra to Maharaja Sawai Jai Singhji on the occasion of the latter's Yagyopovit (holy thread) ceremony held on Chait Bud 3rd Samvat, 1771. He also began to teach the Vedas to Maharaja Sawai Jai Singhji from Jeth Bud 13th Samvat, 1772, Sal-Samvat, 1771, on the completion of which he was granted village Sri Kishanpura for Rs. 600/- per annum. The custom of teaching Gayatri Mantra by the descendants of Samarat Jagannath to the Rulers of Jaipur is observed up to the present day.

The present descendants of Samrat Jagannath hold seven villages yielding an income of 8 to 10 thousand rupees per annum.

Pandit Keval Ram was also one of the prominent astrologers in the service of Maharaja Sawai Jai Singhji. He was an Uddambri Gujrati Brahmin and belonged to Modhasa (in Gujarat) whence he came to Jaipur. Maharaja Sawai Jai Singhji was pleased to confer on him the title of 'Jyotish Rai' which up to the present day is enjoyed by his descendants in Jaipur. He wrote the following seven books:—

1. *Jai Vinod*
2. *Vibhag Sarni*—Sanskrit translation of Logarithmic's tables of Napier.
3. *Mithya Jiwachhaya Sarni*—on the basis of a bench work.
4. *Drig Paksh Sarni* } on the basis of de la Hire's tables.
5. *Drig Paksh* }
6. *Tara Sarni* on the basis of Ulugh Beg's book with necessary modifications.
7. *Brahmpaksh Niras.*

All these books are in Sanskrit manuscript and are very helpful in the preparation of Panchanga and in the calculation of the position of Grahas (planets), Tithis (lunar days), Nakshtras (position of stars).

The present descendant Pandit Nandlal Jyotish Rai is designated as Darogha, Jyotish Yantralaya. He holds a land grant of Rs. 1,500/- per annum. 10 Jyotishies (astronomers and astrologers) work under him; all of them have land grants.

Not content with observations in India and the information contained in books, Sawai Jai Singhji sent out several skilful observers to other countries. Thus Muhammad Sharif, a Mohammadan, was sent to some places in the Southern latitude, and Muhammad Mehdi to the further islands. In 1728 Father Figueredo, a Portuguese Jesuit, was sent to Portugal. At Maharaja Jai Singhji's request two priests set out from Chandranagar in 1734; one of them was Father Bondier and the other Father Andre Strobel. The maps and globes of the Feringhes (Europeans) were obtained from Surat.

The names of the early astronomers and mathematicians referred to in works attributed to Maharaja Sawai Jai Singhji are:—

Euclid	Circa	B.C.	290
Hipparchus (Abarkhas)	,,	,,	130
Ptolemy (Vitlamayus)	,,	A.D.	150
'Abd-ul-Rahman b. 'Omar abul-Husain al-sufi	Died	,,	986
Nasir al-Din al Tusi	Born	,,	1201
'Ali b. Muhammad al-Sayyid al-Sharif	—	,,	1339-1414

Jamshid b. Mes 'ud Jijat al-Din al-Kashi	Circa	,,	1440
Ulugh Beg	Died	,,	1449
Maulana Chand	Circa	,,	1550

Of those who came actually into personal contact with Sawai Jai Singhji names of the following deserve mention :—

Muhammad Sharif, Muhammad Mahdi, Padre Manuel Figueredo, Father Andre Strobel, and his companion, Father Claude Boudier, and Don Pedro de Sylva.

Don Pedro de Sylva, who, according to Hunter, was a physician and an astronomer, resided at Jaipur with Jai Singhji. De Sylva died about A.D. 1792. His descendants still hold one village in Tankha and one in Inam.

Sawai Jai Singhji possessed at least some of the works of Ptolemy, Ulugh Beg, P. de la Hire, J. Flamsteed, and also certain European astronomical tables and mathematical text-books. He had, as mentioned already, Ptolemy's '*Almagest*' translated into Sanskrit, and a text on the astrolabe compiled, and he brought up to date Ulugh Beg's celebrated catalogue of stars. The instruments themselves are evolved from the types used by the Muslims, and Jai Singhji's inspiration was avowedly of Muslim origin.

Jai Singhji copied the instruments of the observatory at Samarkand. His masonry instruments were designed after the notions taught by the Muslim astronomers and had absolutely nothing in common with those described in Hindu works.

Jai Singhji himself refers to La Hire's table and to other European tables and in the palace library at Jaipur a copy of Flamsteed's great work is still to be found. La Hire was a French scholar of repute who lived from 1640 to 1718 A.D. John Flamsteed, the first Astronomer Royal, lived from 1646 to 1720 A.D.

The old fort at Muttra known as Kans-ka-Kila was rebuilt by Raja Man Singhji of Jaipur. On the top of this fort Jai Singhji built the last of his observatories. The whole of it has now disappeared.

The work on Hindu ritual, *viz.*, '*Jaisingh Kalpadrum*', giving detailed descriptions of fasts, penances and devotions, to be observed on certain days, with the appropriate hymns to be recited was written by Pundarik Ratnakar, one of Jai Singhji's Gurus. It was finished in 1714.

Pundarik Ratnakar belonged to a Maharashtra family of Shandilya Gotra and was the son of Deo Bhatta, a resident of Benaras. The family of Bhatta Ratnakar came to Amber in Samvat 1764 (1707 A.D.). In Samvat 1765, Bhatta Ratnakar was granted Rs. 4,000/- for Vershasan. The sum was enhanced to Rs. 8,000/- and the title of 'Brahma Murti Vajpaiji' was conferred on him in Samvat 1767. In Samvat 1768, he was granted another title of 'Brahma Murti Pundrikji' and the Vershasan grant was further enhanced to Rs. 12,000/-. This grant was still further enhanced to Rs. 25,000/- and Rs. 35,000/- in Samvats 1770 and 1771 respectively.

In Amber there is a tank named Ratna Sarowar after his name. In the centre of this tank, there is a tomb where his 'foot print' (Charan Chinah) still exists.

The present descendants of Pundarik Ratnakar in Jaipur are Padmakar and Umakar. They enjoy a land grant of Rs. 3,500/- and Rs. 2,500/- respectively.

SIR JADUNATH SARKAR ON JAI SINGHJI'S WORKS ON ASTRONOMY*

WHY JAI SINGH BUILT HIS OBSERVATORIES

COL. JAMES TODD, not a very friendly critic of Sawai Jai Singh, has admitted that "he erected monuments which irradiate this dark period of the history of India." And, indeed, no history of Jai Singh would be complete without an account of his astronomical studies and observatories, which are the greatest contribution of the House of Jaipur to the enrichment of India's cultural life. "Jaipur became the refuge and sanctuary of Hindu learning, and it was from thence that Colonel Polier procured in 1779, the first complete copy of the Vedas, which he afterwards presented to the British Museum." (An English Officer, writing in the *Calcutta Govt. Gazette*, 1820).

Five of the astronomical observatories built at Delhi, Jaipur, Ujjain, Muttra and Benares by him still survive. Their genesis is thus given in his own words in the preface to his Table of Stars named *Zij-i-Muhammad Shahi*, in which he speaks of himself in the third person :—

"This admiring spectator of the theatre of infinite wisdom . . . was, from the first dawning of reason in his mind and during his progress towards maturity, entirely devoted to the study of mathematical science, ... and by the aid of the Supreme Artificer he obtained a thorough knowledge of its principles and rules. He found that the calculation of the places of the stars, as obtained from the tables in common use (Sanskrit, Arabic and European) in very many cases give them widely different positions from those determined by observation especially in the appearance of the new moons. Seeing that very important affairs,

* Extracts from the 'Jaipur History' by Sir Jadunath Sarkar, kindly sent to us by Mr G. N. Bansal.

both regarding religion and the administration of the Empire, depend upon these, . . . he represented the matter to the Emperor Muhammad Shah, who was pleased to reply :—

"Since you, who are learned in the mysteries of science, have a perfect knowledge of this matter, having assembled the astronomers and geometricians of the faith of Islam, and the Brahmans and Pandits and the astronomers of Europe, and having prepared all the apparatus of an observatory— do you so labour for the ascertaining of the point in question, that the disagreement between the calculated times of those phenomena and the times which they are observed to happen, may be rectified."

"So he (Jai Singh) constructed at Delhi several instruments for astronomical observation. But finding that brass instruments did not come up to the ideas which he had formed of accuracy, because of the smallness of their size, the want of division into minutes, the shaking and wearing of their axes, the shifting of the planes of the instruments etc. . . . . he constructed in Delhi instruments of his own invention, of stone and lime of perfect stability . . . . such as Jai Prakash, Ram Yantra and Samrat Yantra. . . . . . And, in order to verify the truth of these observations, he constructed instruments of the same kind in Sawai Jaipur, Muttra, Benares and Ujjain, ... so that every person who is devoted to these studies, whenever he wished to ascertain the place of a star might observe the phenomena.

"But seeing that in many cases it is necessary to determine past or future phenomena, and also that—the opportunity of access to an Observatory may be wanting—he deemed it necessary that a table be constructed by means of which the daily places of the stars being calculated every year and disposed in a calendar, may always be in readiness.

"After having constructed these instruments, the places of the stars were daily observed. After seven years had been spent in this employment, information was received that observatories had been constructed in Europe and that the learned of that country were employed in the prosecution of this important work. . . . . For this reason, having sent to that country several skilful persons along with Padre Manuel (de Figueiredo) he procured the new tables (of stars) which had been published there thirty years before under the name of Pere de la Hire (*Tabulae Astronomicae*, completed in 1702) as well as the European tables anterior to these (especially Flamsteed's *Historia Coelestis Britannica*, 1712-1725.) . . . . On comparing these tables with actual observations, it appeared that there was an error of half a degree in the former in assigning the moon's place, and there were also errors in the other planets, although not so great,—especially in the times of the eclipses. . . . . . . Hence he concluded that, since in Europe astronomical instruments have not been constructed of such a size and so large diameters, the motions which have been observed with them may have deviated a little from the truth."

Hence, on the basis of his own long researches, he constructed and published his own astronomical tables, named after his suzerain as *Zij-i-Muhammad Shahi*, in 1733.

Jai Singh gathers Scientific Knowledge from Europeans and all the World

With no less catholicity of mind than wisdom, Sawai Jai Singh called to his aid the best scholars of the Hindu, Muslim and European worlds. He took his first lessons in Hindu astronomy from Jagannath Pandit, who later translated at his command the ancient Greek scientist Ptolemy's '*Syntaxis*' from its Arabic version '*Almagest*', into Sanskrit under the name of '*Sidhanta Samrat*' (also known as '*Siddhanta Sar Kaustuva*').

"Jai Singh collected and studied all the available atronomical works." (G. R. Kaye). For the purpose of acquiring manuscripts of the great mediaeval Muslim astronomers and apparatus, and also for making observations, he deputed Muhammad Sharif and Muhammad Mahdi abroad. "Several European works were translated into Sanskrit under his orders, particularly Euclid's '*Elements*', with a treatise on plane and spherical trigonometry, and on the construction and use of logarithms, ... and also a treatise on conic sections. . . . Maps and globes of the Feringhis were obtained from Surat." (Kaye).

But he would not be content unless he could quench his thirst for knowledge at the very fountain-head of European science. For this purpose he sent a request to the King of Portugal, through the Viceroy of Goa, for a learned European scientist and also a physician to be sent to Jaipur, whose expenses he would pay. The scholar chosen was Padre Manuel de Figueiredo, the Superior of the "Mogor Mission" at Agra. He left Goa about 6th November, 1730 for Jaipur, whence he was afterwards sent to Europe with money for buying books and instruments. The doctor who accompanied him to Jaipur was Pedro da Silva Leitao, who settled at the Kachhwa capital and whose son or grandson, Xavier da Silva, known as "Hakim Shewair", was an influential courtier in 1799. But in the twentieth century his descendants have sunk very low owing to ignorance and economic decay.

Next came, by the Rajah's invitation, two French Jesuits, Claude Boudier and another, who left Chandernagore on 6th January 1734 and reached Jaipur after taking astronomical observations on the way, at Benares, Muttra and Delhi. Andre Strobel, a Bavarian Jesuit, arrived by ship at Goa on 30th September 1737, reached Jaipur on 4th March 1740, and after passing some years at Jaipur, went away to mission work at Narwar in 1749. (He died at Agra in 1758). Another Bavarian Jesuit, Antoine Gabelsperger, accompanied him to Jaipur but died next year. Jai Singh's observatories thus had the benefit of the latest state of scientific knowledge in Europe.

Jai Singh's Chief Astronomical Instruments

Technical details and a precise appraisement of the scientific value of each instrument* in these

* For an account of Jai Singh's astronomical instruments, the readers are referred to "Maharaja Sawai Jai Singh II (1686-1743)"—by Prof. M. F. Soonawalla, published in Science and Culture, April, 1944.—Ed. *Sc. & Cul.*

observatories would be out of place in a history like this. For them the reader is referred to A. H. Garrett and C. Guleri's *The Jaipur Observatory and its Builder* (1902), G. R. Kaye's *memoir* in Vol. 40 of the new Imperial series of the Archaeological Survey of India, and the last-named writer's short but useful *Guide to the Old Observatories at Delhi, Jaipur* etc. (1920). These works supersede earlier descriptions like those of Tieffenthaler (*c.* 1745) and Dr W. Hunter (1793).

The final appreciation of his scientific achievement can be best given in the words of a specialist like G. R. Kaye.

"The Hindus had no instrument of precision before Jai Singh's time; neither were they interested in making practical observations of the heavenly bodies; their rules and the elements given in their approved works sufficed them. . But the work of Jai Singh was exactly of that nature which differentiates between the two schools, –Hindu and Muslim astronomy. What the Muslim astronomers had, and what the Hindus lacked, attracted Jai Singh.

"That Jai Singh made no new astronomical discoveries is hardly a fair criterion of the value of his work; for, indeed, a great deal of the most valuable astronomical work is not concerned with new discoveries. His avowed object was the rectification of the calendar, the prediction of eclipses, and so on. Considering the state of the country in which Jai Singh lived, the political anarchy of his time, the ignorance of his contemporaries, and the difficulties in the way of transmission of knowledge, his scheme of astronomical work was a notable one, and his observatories still form noble monuments of a remarkable personality."

PROFESSOR S. CHANDRASEKHAR, F.R.S.

DR. S. CHANDRASEKHAR who has earned international reputation as one of the foremost astrophysicists of the present time had his early training in the Madras Presidency College. Even as a student at the early age of nineteen he completed a piece of original work on "Compton Scattering and the New Statistics", which was published in the *Proceedings of the Royal Society*, London, in 1929. This work is an extension of a paper by Dirac and deals with Compton Scattering by electrons in the atoms. It is clear that electrons having different momenta will produce different Compton shifts and the intensity of any particular shift will depend on the number of electrons in that state. It is well known that electrons in the atom obey Fermi-statistics. Chandrasekhar, by taking the Fermi-distribution law for electrons showed that the distribution of the intensity about the primary frequency for the scattered radiation was parabolic, whereas an exponential distribution of the intensity was obtained by Dirac by assuming Maxwell-Boltzmann Statistics for the electrons. Compton Scattering is usually calculated for stationary electrons. Chandrasekhar's work may be said to be an extension of the theory of Compton Scattering for the electrons in motion. The parabolic distribution law as found by Chandrasekhar appears to be confirmed by observations. This work clearly showed the zeal and enthusiasm of young Chandrasekhar and his keen interest in the most recent developments in physics, for it was only in 1929 that Fermi-statistics came into existence and its great practical importance was realised by Pauli and Sommerfeld in 1928. Unlike other brilliant students Chandrasekhar never sat for any of the competitive service examinations, but a Government Scholarship enabled him to proceed to Cambridge after his graduation from the Madras University.

The stay at Cambridge gave him great opportunities to study the application of the new statistics to problems of Astrophysics. He was initiated in this fascinating domain of science

Prof. S. Chandrasekhar

by the work of Prof. Milne who was then trying to establish a new stellar model in which a star was conceived to possess a dense core containing Fermi electrons, and a gaseous envelope surrounding it. Following Milne, Chandrasekhar worked out a very exhaustive theory of white dwarfs, a type of stars which remained a puzzle to the astrophysicists for a long time. These stars have normal masses of the order of the sun but relatively very small radii ; they are underluminous, *i.e.*,, relatively very much less bright, and are characterised by

abnormally high densities one cubic inch of the stellar matter weighing about a ton. The electrons in such stars according to the new theory should obey the Fermi-distribution law, and are called *degenerate* in technical language. Eddington showed some years earlier that there is a definite relation between masses of stars and their luminosities, *i.e.*, the total amount of radiation they emit in one second, which is known to astro-physicists as the Mass-Luminosity relation. Chandrasekhar found that there is a corresponding relation between the masses and the radii in case of white dwarf stars. The determination of stellar masses is rather difficult, and a direct determination is dependent on some fortuitous circumstances. But Eddington's Mass-Luminosity relation for gaseous stars enables us to determine in a rough way their masses when their luminosities can be measured. Chandrasekhar's Mass-Radius relation serves the same purpose as regards determination of masses of white dwarfs from their radii.

His investigations led him to the further striking result that the career of a star depends on its mass, and there is a critical mass value which sharply divides the paths of evolution of stars. If the mass of a star be less than 5·75 times the mass of the sun divided by the square of the mean molecular weight of the stellar material, the degeneracy of the electron gas in the interior of the star will always begin at a certain stage of its evolution; whereas for stars of larger masses the electrons will always remain in the state of perfect gas. A star of smaller mass than this critical one will therefore, in course of evolution when the source of its energy is exhausted, end its career as a white dwarf. For stars of larger masses the situation is quite different. Such a star will behave as a perfect gas sphere and cannot allow the growth of degeneracy within itself. So in course of evolution the star will first radiate all energy that can possibly be produced within it, and then shorn of every internal energy-supply it will continue to contract. But degeneracy is not allowed even under great pressure produced by contraction as long as its mass is above the critical value. It gets an opportunity to escape from this situation when the pressure of the flow of an immense amount of radiation though it becomes enormous. The star is blown up and some matter is ejected from its outer parts till its mass falls below the critical mass mentioned above. The paths then open for it to follow the career of a white dwarf. There is a class of stars frequently observed which suddenly burst forth as it were, and rapidly increase in brilliancy even to a value more than a million times the brilliancy of the sun, and then slowly decrease in brightness and often become so dim ultimately that they can be observed only through a very high power telescope. These are known as Nova and a particular class which appears to radiate a large part of its mass is known as Supernova. During the flare-up of a Nova or Supernova, spectroscopic analysis reveals that its hot gaseous mass is expanding outwards with terrific velocity. Chandrasekhar connects such a Nova or Supernova phenomena with the bursting of a contracting star. The theory has not yet reached its final stage as much observational material must be collected before a full confirmation is possible. It has, however, found a certain amount of support in the discovery of the "Crab Nebula" which is an extensive luminous cloud formed perhaps by the gas masses expelled during a Supernova explosion in the year 1054 A.D., which was observed by Chinese and Japanese astronomers. The central star of the Crab Nebula has been found to be a white dwarf of mass comparable to that of the sun. Chandrasekhar has done extensive researches on the problem of internal constitution of stars. His famous book '*The Introduction to the Study of Stellar Structure*' contains indeed only a selected portion of his valuable contributions to the subject. Besides he has also given a theory of the chromosphere, *i.e.*, the gaseous outer envelope of the sun and stars.

Chandrasekhar now appears to be greatly absorbed in the problems of stellar dynamics, on which he has already published two comprehensive articles in the *Astro-physical Journal.* His monograph on the subject "Principles of Stellar Dynamics" is unfortunately not yet available in India. In this treatise, he is said to have very elegantly developed the dynamical methods of interpreting the motions of stars in the galaxy, spiral nebulae and star clusters. This book, according to its reviewer in *Science,* should exert a profound influence on the future developments in the field of galactic dynamics. Chandrasekhar has been developing in the recent issues of the *Astro-physical Journal* a statistical method applicable to the large scale gravitational field of stellar worlds. An introducton to his ideas may be obtained from his masterly article on the "Stochastic Problems in Physics and Astronomy" published in the *Review of Modern Physics,* Vol. 15, 1943.

Apart from the intrinsic merit of Chandrasekhar's work his extensive contributions to astro-physical literature show his immense capacity for taking pains especially in the line of numerical work, and his mathematical analysis is marked by a scrupulous care for rigour. He was invited for a lecture tour to Soviet Russia in 1934, and was for some time Associate Professor of Astro-physics in the Harvard University. He held for a time a Fellowship in the Trinity College, Cambridge. Lately he has been appointed Professor of Astronomy at the famous Yerkes Observatory under the University of Chicago

and has gathered round him an enthusiastic band of younger American workers.

Chandrasekhar is a son of Mr C. Subrahmanyam Iyer, elder brother of the famous physicist, Sir C. V. Raman, who retired some years ago as Accountant General from the service of the Government of India and is an amateur musical critic. It is a pity that, even a man of Chandrasekhar's stamp could not be offered a post befitting his abilities in the country of his birth. We are, however, glad to learn that attempts are being made to get him back to India. The amount of scientific talents in this country is not so large that we can spare a man of Chandrasekhar's type. He should be in this country, training our young hopefuls in the methods of science, and if he is allowed to remain longer in the U. S. A.*, the gain will be all on the side of that country, and the loss will be India's.

R. C. M.

* But in spite of the appreciation of the American men of science for Chandrasekhar, is it not somewhat shocking to find that, according to U. S. A. law, he cannot be a citizen of that country Ed. *Sc. & Cul.*

Notes and News

ROYAL SOCIETY PRESENTS *'PRINCIPIA'* TO THE ACADEMY OF SCIENCES

The recent presentation of a copy of Newton's celebrated work *'Principia'* to the Academy of Sciences of the U. S. S. R., at the request of the Royal Society, represents another significant attempt at promoting a feeling of good will and mutual co-operation among men of science of these two great countries. According to a report in *Nature*, the occasion was celebrated by an interesting ceremony which took place in Moscow on January 6, 1944. H. M. Chargé d' Affaires presented a copy of the first edition of Newton's *'Principia'* to a deputation representing the Soviet Academy of Sciences. The present was further accompanied with the original draft of a letter by Newton to Prince Alexander Menshikov, informing the latter of his election to the fellowship of the Royal Society in 1714. It may be noted that Prince Menshikov, a distinguished figure at the time of Peter the Great, was the first Russian to be chosen for this British honour. The book was handsomely bound in polished Levant Morocco and contained a sheet of vellum on which the signatures of the President and Council of the Royal Society, authorizing the gift, were recorded. The President of the Academy failed to be present at the time of presentation owing to indisposition and his part was played by Academician Baykov, the first Deputy President. It is further stated in the report that the Academy now appears to be the only scientific body in the U. S. S. R. to possess a copy of the first edition of Newton's monumental work.

INDICTMENT OF IMPERIAL CHEMICAL INDUSTRIES AND DU PONT DE NEMOURS

The recent announcement of the U. S. Government's indictment of the Imperial Chemical Industries (I. C. I.) and Du Pont de Nemours of U. S. A. for having violated the Sherman Anti-Trust Act has excited much comment in the Press all the world over as an event of far-reaching consequence. These two gigantic chemical firms on the two sides of the Atlantic formed an international combination or cartel which is now alleged to be contrary to the Anti-Trust Laws. Accordingly charges have been brought against Lord McGowan and Lord Melchett, of I. C. I., Mr Lamount Du Pont, Chairman of the Du Pont De Nemours and Mr W. S. Carpenter, President of the Remington Arms Company, and several others. The inclusion of such distinguished personalities as two British peers in the list of the accused has naturally made the news all the more exciting.

Combination of Big Business or the cartel system in the field of international trade has been for a long time a recognized practice under capitalistic economy. The indictment appears to have dealt a major blow to the cartel system and have raised the important question whether the captialist countries have at long last really decided to do away with a system that found so much favour until recently. While it is well-known that the cartel system undoubtedly introduced great orderliness, the same system gave rise to secret agreements involving the control of prices and of competition in a manner often injurious to the

interest of the consumers. Furthermore, the system was held responsible for shortage of essential materials and of skilled industrial labour during war and unemployment and closing of plants during peace and led to concentration of power which was not infrequently abused in the hands of such combinations.

In this connection the recent incidence of a cordite charge explosion at the I. C. I.'s Glasgow office may be mentioned. Three Scottish youths, apparently belonging to the junior branch of the Scottish Nationalist Party, placed a tin containing 5 lb. of cordite at the door of the I. C. I. offices in Glasgow and caused an explosion. It was revealed in course of investigation that their action represented a political demonstration against the company which, they were of opinion, planned to strangle Scottish economic life. This incidence was shortly followed by another explosion at the same premises, believed to be caused by five hand granades that shattered the basement and ground-floor windows.

The Scottish explosions at any rate demonstrate the common people's suspicion for the intentions of Big Business in their own country at a time when Great Britain is involved in a life and death struggle. And again while Great Britain and U. S. A. have joined hands in destroying their common enemy and introducing a new world, news comes of the U. S. Government's indictment which is so damaging to the prestige of the two great and representative chemical companies co-operating with each other, it is alleged, for the establishment of world monopoly. Lord McGowan has, however, defended his stand by stating that such scheme of international co-operation in industry would be necessary in any orderly planning for post-war industry. These are events which forebode a general offensive against India's nascent chemical industries in the years to come. Indian chemical concerns will do well to watch and organize a defensive in time.

SOLAR ECLIPSE EXPEDITION

An expedition of leading Mexican astronomers to observe the total solar eclipse on January 25, from Peru was jointly sponsored, according to a report in *Science*, by the Mexican Federal Government, the State of Puebla and the University of Mexico. The expedition headed by Dr Joaquin Gallo, Director of the Mexican National Observatory at Tacubaya included Dr Luis Enrique Erro and Dr Carlos Graeff Fernandez, Director and Assistant Director of the Astrophysical Observatory at Tonanzintla, among other distinguished astronomers in the party. Dr Gallo is one of the most able and experienced astronomers to lead such expedition. He took part in the 1905 eclipse in Spain as a member of the Mexican expedition and in 1922 led the Mexican expedition to observe the total eclipse visible in northern Mexico.

The two observatories at Tacubaya and Tonanzintla provided the necessary instruments and equipment, including modern eclipse cameras and spectrographs. The instruments were set up at Cajamarca in Peru, where the total solar eclipse was expected to be visible with the best advantage. The zone of the totality extended across South America through Brazil and Peru. Owing to war conditions, elaborate arrangement for observing the eclipse could not be made. Furthermore, this appears to be the only expedition from North America, as no eclipse expedition was reported to be arranged from the United States of America this year.

TRAINING IN SCIENCE AND TECHNOLOGY IN GREAT BRITAIN

The scientsts in Great Britain, it appears, are determined to give their Government no rest whatsoever over the question of more and yet more expansion of scientific activities in all possible fields and directions. According to a report of the Parliamentary correspondent of the *Times*, about one hundred members of Parliament of all parties have recently urged the Government to take bold action to encourage scientific and technological training and to stimulate and co-ordinate research work of all kinds as an aid to post-war reconstruction policies. The motion has been signed by members mostly belonging to the Parliamentary and Scientific Committee. There are also among them several members of the Tory Reform Committee. The sponsors of the motion include Mr E. W. Salt, Lord Hinchingbrooke, Dr A. V. Hill, M. P. Price, Sir George Schuster and H. Graham White. The following is the text of the motion:

"That this House, recognizing that if the United Kingdom is to maintain its position in the post-war world and carry out effective plans for physical reconstruction and social betterment, research and the application of scientific knowledge in all fields must be promoted on a far bolder scale than in the period 1919-39, urges his Majesty's Government forthwith:

(1) To assure the universities that in planning future developments for research, teaching, and higher learning as a whole they will receive support from the State on a much larger scale than hitherto.

(2) To arrange that education and training in schools, technical colleges, and universities shall be directed at the earliest date towards providing a far greater number of persons highly trained in science and technology.

(3) To set in motion schemes to ensure a substantial and co-ordinated expansion of research

activity by private firms, co-operative industrial research associations, and State and other research establishments; and to this end, to provide assistance by adjustment of taxation, by more generous financial grants and through adequate priorities both in demobilization and for materials required for building and equipment."

HEAVY INDUSTRIES IN BRITISH INDIA

THE All-India Manufacturers' Organization, Bombay, has recently issued a monograph to indicate the present position of British India with regard to heavy industries and the possibilities of setting up new ones in future. The case of eleven provinces has been reviewed separately, and specific problems and the lines of future industrial development for each province have been briefly outlined. To give a rough idea of the industrial position of the various provinces, the monograph has quoted figures for income tax which these provinces pay in a normal year to the Government of India. The tax collected during 1941-42 in Bombay was Rs. 6·97 crores, in Bengal Rs. 6·67 crores, in Madras Rs. 2·17 crores, in the United Provinces Rs. 1·47 crores, and in the Punjab Rs. 1·32 crores. In Bihar, Sind, Central Provinces and Berar and Assam, the income tax revenue ranged between Rs. 65 and Rs. 25 lakhs. The remaining two provinces paid less than Rs. 25 lakhs. These figures are themselves significant and reflect the poor taxable capacity of the Indian people and hence the industrial backwardness of the country they inhabit. About 77 per cent of the population in British India depend on agriculture, while only 10 per cent are engaged in industry. It is needless to point out that there is a great scope for establishing manufacturing industries in the various provinces.

The monograph has given a list of some important heavy industries, *e.g.*, automobile, aeroplane, ship-building, internal combustion engines, railway locomotives and power machinery generally, industrial machinery and machine tools, iron and steel, heavy electrical industries, special defense machinery, heavy chemicals, such as sulphuric, hydrochloric and nitric acids, chlorine, caustic soda, soda ash, dye-stuffs, and rayon. It is suggested that to start with each province should choose two of the above heavy industries for which the province offers best opportunities for development and immediately set to exploring ways and means to establish them. A Committee or a Board may be constituted with leading industrial magnets and business men of each province, who should select the industries and bring together men of resource and enterprise to organize joint-stock companies, frame schemes and estimates and keep themselves ready to start the two heavy industries after the war. By such provincial drives, the monograph states, all the key industries necessary for industrialization of this country may be set up. What is wanted is that leading industrialists and citizens in every province should take immediate steps to help the industrialization movement to the best of their opportunity while the war is still in progress.

NEW THEORY OF ZODIACAL LIGHT

THE origin of the zodiacal light formed the subject of an interesting paper by V. G. Fessenkoff in *Astro. J. Soviet Union*, 19, No. 4; 1942, of which a summary has been published in a recent issue of the *Astrophysical Journal* (98, 129; 1943). There is common agreement about the fact that the light principally results from the scattering of sunlight by small dust particles. But the astrophysicists could not properly account for the existence of an oblate cloud of cosmic dust in the neighbourhood of the sun. Fessenkoff now advances his theory that this cosmic dust has its origin in the collisions between sporadic meteors and asteroids. Such meteoritic collisions with planets and satellites without an atmosphere are, however, established facts. The asteroids, it is proposed, suffer the same collisions producing dust particles which cannot be retained owing to the insufficient gravitational attraction of the asteroids. This process of dust formation is particularly active throughout the asteroid zone. From his calculations, Fessenkoff concludes that a dust cloud produced in this way will form an oblate spheroid, with the sun at its centre, surrounded by a dense ring of dust in the asteroid zone. The conical zodiacal light then arises from this oblate spheroid of cosmic dust, while the dense ring of dust in the zone of asteroids is accountable for the uniform zodiacal band visible along the entire ecliptic throughout the night.

PREHISTORIC SKELETONS IN INDIA

THE Principal Information Officer, Government of India, has recently issued a note stating that a rich pre-historic microlithic and bone industry, besides remains of several partly fossilized bones and three incomplete human skeletons, has been discovered in Gujarat by the Director-General of Archaeology in India. The discovery of so many human and animal remains and a bone industry comprising tools and articles of decoration, such as beads in association with microliths, is the first of its kind in India. The archaeologists are of opinion that this discovery, properly interpreted, may lead to results of the greatest importance for the study of early man in India. The expedition worked in co-operation with the Director, Deccan College Post-

Graduate and Research Institute, Poona, and the staff of the History Department. It has been conducting extensive excavations at Langhraj, Mehsana Prant, Paroda State (Gujarat).

THE STRUGGLE FOR MARKETS

APROPOS the Editorial in this issue, the following Reuter's telegram from New York appearing in *Hindusthan Standard* of 26-4-1944 will be of interest.

"The *New York Times* writes that American exporters charged on Friday that in violation of Lend-Lease the British are processing lend-lease carbon black into news ink and exporting it to India, while the Controller of Imports in India refused to issue import licenses for American news ink. They said their Indian importers were advised by the Controller last December that 'mere willingness by exporters to supply goods is not sufficient justification for issuance of licence to import goods from a difficult currency country'. The exporters pointed out that the United States are virtually the only source of carbon black used for the manufacture of news ink and they are surprised to learn that Britain is being permitted to rob American exporters of their normal markets'. They added, 'It seems strange that Britain has man power to spare to process United States raw materials in a business in which the United States has the lead."

This is verily the struggle for markets.

INDUSTRIAL RESEARCH PLANNING

THE first meeting of the Industrial Research Planning Committee was held at Bombay on March 20, 21 and 22 last.

The following were present—Sir R. K. Shanmukham Chetty, K.C.I.E., Seth Kasturbhai Lalbhai, Colonel Sokhey, Dr M. D. Qureshi, Dr Hamied, Dr S. K. Mitra, Sir S. S. Bhatnagar, Dr A. L. Sundara Rao.

The Committee was of opinion that a comprehensive national register of all the persons qualified to conduct scientific and industrial research was essential and that the task of initial preparation and maintenance of this register might be delegated to an unofficial agency like the National Institute of Sciences of India. For the purpose of preparation of this register the minimum qualification must be the B.Sc., B.E., or an equivalent degree in science or technology.

The Committee further decided that a national register of persons actually engaged in scientific research should be prepared and kept up-to-date from time to time. This register should contain the names of those persons who after taking the University degree in science or its equivalent are engaged in research work in universities, research institutions, private laboratories, and industry.

The Committee has undertaken the initial preparation of this register (see advertisement pages of the journal).

With a view to getting the names of research workers employed in industry a questionnaire is being addressed to the Federation of Indian Chambers of Commerce and Industry, the Associated Chambers and other Chambers of Commerce, all Directors of Industries, Universities, Defence Services, Government Departments.

With a view to collecting the completest information about the existing facilities for research available by way of research personnel, equipment and library, the Committee decided to issue questionnaire of universities, research institutions and industries.

Sir R. K. Shanmukham Chetty is the Chairman of the Committee and Sir S. S. Bhatnagar is the Secretary. The Committee is constituted under the auspices of the Council of Scientific and Industrial Research. Dr A. L. Sundara Rao has been appointed assistant Secretary to the Committee.

ADAIR, DUTT RESEARCH FUND

AT the meetings of the Adair, Dutt Research Fund Committee held under the auspices of the Indian Science News Association on March 1 and April 11, 1944, the following scholarships were awarded.

Scholars	*Subject*	*Under whom research to be carried*
1. Govinda Ram Debnath	Androgenic Hormones (Chemistry).	Prof. J. K. Chowdhury, Dacca University.
2. Arobinda Nath Bose	Processing of food-stuffs on vitamin values (Higher Technology).	Prof. B. C. Guha, Calcutta University.
3. (Mrs) Amina Rahman	Method of estimation of the vitamin of the "B"-Groups and their assay in Indian foodstuffs (Nutrition).	Prof. B. C. Guha, Calcutta University.
4. Amal Chand Ghosh	Cyclotron work (Higher Technology).	Prof. M. N. Saha, Calcutta University.
Renewal for the Second Year		
1. Satyendra Nath Ghosh	Measures of the intensity of the night sky (Physics).	Prof. S. K. Mitra, Calcutta University.
2. Sailendra Nath Ghosh	Feeding in Carps (Zoology).	Prof. H. K. Mookerjee, Calcutta University.

ANNOUNCEMENT

We are glad to niform that Mr P. K. Dutt of the well known firm of Messrs Adair, Dutt & Co., Ltd. has placed a further sum of Rs. 3,000/- at the disposal of the Adair, Dutt Research Fund Committee. The total sum uptodate amounts to Rs. 12,000/- only.

SCIENCE IN INDUSTRY

SOAP AS LUBRICANTS

The use of soap as a lubricant is not a new thing. The fact that it is clear, easy to handle, concentrated and more readily adoptable has recommended its use almost universally for lubrication purposes. A note in the *Scientific American* indicates the many uses to which soap has been put in industry in recent years with promises of yet many more.

Drilling, drawing and turning on a lathe are some of the commonest operations involving the use of lubricants, through which metals must pass before being shaped into usable objects. In drawing wire, for instance, the very large friction of nearly 18,000 to 30,000 pounds per square inch is produced in the die, which can only be reduced through use of lubricants. Powdered soap made from tallow or a combination of tallow and palm oil, when the latter is available, serves as a good lubricant in dry drawing. In wet drawing, however, a soap solution in water is used, and the wire and the die are either submerged under the solution or the solution is dripped over them as the drawing is in progress.

Soap forms an important component in the manufacture of a large number of new greases which have recently been produced. The use of soap in grease makes the latter adhere more closely to the rotating surfaces and prevents its leaking away from points of friction. Moreover, gasoline which quickly dissolves ordinary grease has little action on these new varieties processed with soap, and as such these lubricants can be advantageously used in pumps and curburetor valves frequently coming in contact with gasoline. Grease lubricants containing a certain proportion of soap are more resistant to extreme cold and sudden temperature changes and are now largely used in aircraft industry.

Some other uses of soap enumerated in the note include the use of soap coating in the manufacture of 37 mm. cartridge cases. This eliminates the need for copper plating. Soap is extensively used in the preparation of lubricants for drawing copper and brass tubes and wire, also of cups in the production of shell cases for ammunition. The property of soap to improve the stability of oil emulsion and increase its film strength is utilized in cutting oils which have been developed to meet the requirements of many kinds of high speed war production.

PLASTIC FROM SAW DUST

Science News Letter, January 1, 1944, reports the development of a new plastic from waste saw dust by Dr Robert A. Hardin, Chairman of the industrial education department of the University of Oklahama. The waste of saw dust and savings from saw mills and lumber manufacturing plants, Dr Hardin has revealed, amounts to as much as 76 per cent of the country's forest products, and this led him to undertake research in the possible utilization of this waste product.

The plastic he has developed is black and opaque and has high tensile strength and resistance to moisture absorption. Its tensile strength has been measured at 9,000 pounds per square inch. Besides its resistance to moisture, the new plastic yields little to the action of acids and is not inflammable.

The black colour of the new product, which is often a disadvantage, is due to the presence of lignin in the wood. During the process of treatment, lignin turns black and makes the colour of the plastic so. The colour disadvantage has, however, been sufficiently countered by the lower cost of production. The lower cost arises from the fact that the new plastic requires only 25 per cent of the costly resin, which is much less than the amount consumed in the manufacture of other plastics now in use. The cost of a plant capable of producing two tons of the new plastic daily has been worked out at 133,000 dollars, including plant location, building and total expenses for one year operation. In his model manufacturing plant at the University of Oklahama, Dr Hardin has also moulded his new product into several finished articles.

HIGH-SPEED MOTION-PICTURE CAMERA

An ultra-high speed camera, known as the Western Electric Fastax High-Speed Motion-Picture Camera, has been recently developed in the Bell Telephone Laboratories and manufactured by the Western Electric Company. At their top speed, the Fastax cameras are capable of taking pictures at the rate of 8,000 per second, which means an exposure period of 33 millionths of a second and a film speed of about 70 miles per hour. Such cameras have been designed to use both 8 mm. and 16 mm. films. The cameras using 8 mm. film take pictures at the rate of 300 to 8,000 per second, whereas the 16 mm. model has a rate of 150 to 4,000 pictures a second. The ordinary line voltages of 110 to 125 volts may be used to secure the top speed and lower speeds can be obtained by applying smaller voltages through the use of rheostats in series with the motor.

The Fastax cameras are of the continuous-motion type, as distinct from the stop-expose-

advance type of the slow motion cameras, and employ rotating prism or optical compensator to produce the succession of images. The 8 mm. model uses an eight-sided prism and the 16 mm. model a four sided prism between the lens and the sprocket, permitting eight and four pictures respectively per prism revolution. The images formed by the lens are refracted by the rotating prism to meet the film moving with great speed. This arrangement makes possible continued exposure throughout the period that the film travels past the aperture. Either 50 ft. or 100 ft. spools of film are used in both these types. The total time of exposure, at full voltage, for a film length of 100 ft. does not exceed 1·25 seconds.

The Fastax cameras, because of their ultra-high speed, have opened up possibilities hitherto unthought of in the field of research and investigation. The Fastax can photograph action far too fast for the ordinary slow motion camera and reveal innermost secrets of mechanical parts moving with high speed. In one set of investigations, the Fastax revealed the heretofore undetected cause of false signals in telephone equipment. In the Bell Telephone Laboratories, these cameras have recently been used to study the action of the vocal cords during speech and the explosive short-circuiting of wires carrying heavy currents of electricity. The Fastax cameras further lend themselves to colour photography of the self-luminous objects. Stress and impact conditions of new equipment designs have been conveniently studied by these cameras working in slower speeds, while medium speeds of about 1,500 to 4,000 pictures per second have been employed to investigate automatic operations, laboratory-controlled breakage of parts and the causes of noisy operation in machines. For a fuller detail as to the construction and design of these cameras and the various uses to which these have been put, the reader is referred to an article by H. J. Smith in the *Bell Lab. Rec.*, 22, No. 1, October, 1943.

INDIAN WOOD FOR TEXTILE AND JUTE MILL ACCESSORIES

INDIAN Forest Bulletin No. 121, issued recently by the Forest Research Institute, Dehra Dun, contains an account of the tests carried out at the Institute on the suitability of Indian timbers for the manufacture of textile and jute mill accessories. Restricted import of the American persimmon (*Diospyros virginiana*) and cornel (*Cornus florida*), the best shuttle woods in the world, and increased demand of wooden articles for textile and jute mills led the Institute to direct its attention to the question of finding suitable indigenous woods for such purposes soon after the war started.

The requirements of wood to be used for shuttle making are very exacting. It should have fine, even and straight grain, good weaving qualities and a density of about 52 lbs. per cubic foot at 12 per cent moisture content. Moreover, the wood should season well without much splitting so as to ensure a reasonable yield, should not split when metal fittings are inserted and finally should be easy to work and smooth to a finish. A large number of timbers which appeared suitable from the data available from their physical and mechanical properties were obtained and tested. The timbers which failed in the preliminary examinations were rejected. Eleven species were finally selected for manufacturing trial and service tests in the mills; the finished shuttles were then tested in weaving mills under factory conditions. The leaflet contains detailed results of these tests in tabular form.

The results of these tests are on the whole satisfactory. *Diospyros melanoxylon* (*ebony*), the light coloured sapwood, appears to be the best timber so far tested for cotton mill shuttles. It gives a life of about 50 per cent of imported cornel wood. *Ougeinia dalbergioides* (*sandam*), *Acacia arabica* (*babul*), and *Schrebera swietenioides* come next to ebony as regards their suitability for shuttle making. Some manufacturers also approve of *Gardenia latifolia* and *Succopetalum tomentosum*, but their supply is limited. Some weaving mills in North India are using 10 quat wood with satisfactory results. Another timber *Buxus sempervirens* (box-wood), available in limited quantities in the high elevation forests of the Himalayas and Kashmir, has, however, been preferred to persimmon and cornel in making shuttles for silk worms and for fine quality cotton fabric. There is yet another timber *Parrotia jacquemontiana* (parrotia) which has been considered suitable for shuttle by certain manufacturers.

The leaflet has further laid down some important precautions regarding the conversion and seasoning of shuttle woods.

RISE AND DECAY OF THE INDIGO INDUSTRY IN INDIA

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Nomenclature

INDIGO (Earlier *indico* from Lat. *indicum* ; Greek *indikon*) belonging to the genus *Indigofera L.*, is a large genus (350 sp.) of herbs of the family Leguminoseae, found throughout the tropical regions of the globe (both in the Old and the New World) with Africa as their headquarters,—India having about 40 species. It is a genus of rather dry climates ; and is subject to disease at the roots in moist climates, where the species are apt to wilt as a result, and where they suffer from inadequate function of root nodules.

Amongst these are the plants best known as sources of the well-proved dye, indigo or anil, which is still the "king of the dyestuffs". Commercial indigo is a paste or powder of the chemical substance, *indigotin* or indigo blue mixed with impurities which are difficult to separate in the process of manufacture. Nothing has been found to equal the permanancy and strength of its deep-blue colour.

The Sanskrit name is *nili* from *nīla*, dark-blue and the Arab name al-nil (through Portuguese) *anil*, gives us *aniline*.

Origin

The latin name *indicum* clearly shows that the Romans knew that the indigo was originally brought from India. As to the wild nature of the plant Roxburgh says "Native place unknown, for though it is now common in a wild state in most of the provinces of India, it is seldom found far from the districts where it is now cultivated or has been cultivated formerly." (De Candolle, 1895.) The existence of a Sanskrit name renders its Asiatic origin more probable. (Brühl, 1908.)

Indigo-yielding Species

The following species have been the source of well-known dark blue dye of commerce. All these plants are stiff-stemmed, weedy-looking annuals or shrubby perennials.

1. *Indigofera arrecta Hochst* (Natal Java plant). —This is a tropical African species, brought into Dutch Indies about 1860. It is the richest variety and later became the chief source of Bengal Indigo. Seeds were obtained from Natal and plants acclamatised in Java. Natal plants are more vigorous in growth than those commonly grown in India and have been proved to yield a much higher proportion of dye from a given weight of plant. It is also used as a green manure and as a catch crop in Malaya peninsula.

2. *I. articulata Gouan* (=*I. argentea Linn*), *Surat indigo*.- It is a native of Tropical Africa, Nubia and Arabia. From Gujarat Arabs took it westwards to the Mediterranean.

3. *I. longeracemosa Boiv.*—This is a native of Madagascar. It was re-discovered and cultivated in Travancore. It is supposed to be one of the most valuable indigo-producing plants in the world.

4. *I. suffruticosa Mill* (=*I. anil*).—It is a native of tropical America. American indigo was brought to China and the Phillippines by the Dutch. This is the Madras variety and has a poorer yield. It is also used as a green manure.

5. *I. Sumatrana Gaertn. Bengal indigo.*—According to Prain (1902) "*I. Sumatrana* is most probably a species developed under cultivation from the wild form of *I. tinctoria* which is indigenous in T. Africa (Nubia)". It is the chief cultivated form in Bengal, United Province and Madras and was introduced by the Dutch from Malayasian region about 1758.

6. *I. tinctoria Linn.*—This species is cultivated in the tropics and may be of Asiatic origin. The Dutch took it to Malayasia and also to the W. Indies.

I. arrecta, *I. Sumatrana* and *I. tinctoria* are the species now cultivated in India.

Woad Plant

In addition to the *Indigoferas*, several widely different plants yield the same substance chemically. The dye prepared from these has borne a synonymous name in most tongues.

Isatis tinctoria L. (Woad plant) is one of these belonging to the Family *Cruciferae* and is a native of the Mediterranean and Europe. This is of historical interest, since upto the middle of the 17th century *i.e.*, before the introduction of indigo it was the only blue dyestuff used by dyers in England and the adjoining countries. The dye was used by primitive Britons to paint their bodies.

The leaves of the woad plant are moistened to a paste slightly fermented, moulded into balls and dried. The plant is still cultivated to some extent.

Early History

Indigo has had a very long history, the beginnings of which are wholly unknown. It was used

in ancient Egypt—for mummy clothes dating perhaps from 2,300 B.C. have been found dyed with it. The manufacture which supplied the trade article must have been already well advanced at that period.

The historical record of this industry goes back almost to the beginning of the Christian Era and the process of manufacture is described by many early travellers to India.

When Rome was at its zenith, indigo was an import received through Alexandria, and being of Indian origin, was called '*Indicum*', as stated before. In the 6th century A.D. Persia was one of India's markets for it and through Persia it reached China overland. Later, in 1200 A.D., indigo reached China no longer by the overland route but by sea from Gujarat and about 1652, the Chinese spread the cultivation to eastern Malayasia.

Bombay Indigo

There is abundant evidence that when European traders first began to purchase and export the dye from India, it was procured from the Western Presidency and shipped for the most part from Surat. Indigo was then cultivated in western and southern India.

Arrival of the Portuguese

The entry of the Portuguese into the Indian Ocean by rounding the Cape in 1498, seems to have led to increased indigo production in India. The dye was carried by the Portuguese to Lisbon and sold by them to the dyers of Holland from 1516 onward. The centre of production remained in Gujarat, Cambay and Surat.

About 1610 Gujrati merchants lived at Goa, in order to trade conveniently with the Portuguese and trade in indigo was more esteemed and valued than trade in cloves both in India and Portugal. Trade with China also continued.

Dutch East India Company

It was the desire to secure a more certain supply of the dye stuff that led to the formation in 1631 of the Dutch East India Company, and shortly afterwards, this led to the overthrow of the Portuguese supremacy in the East. (Watt, 1908).

About 1612, there was an increase noticeable in the amount arriving in Europe. It was sold for use in the place of woad (*Isatis tinctoria*) in Britain and France. The success of the Dutch merchants aroused the jealousy of oth r European nations. "The woad growers and merchants of Germany, France and England were threatened with ruin and to protect them nearly every country passed edicts rendering the importation or use of indigo a criminal offence punishable by death" (Watt, 1908). Efforts to fortify woad against indigo, by the scientific improvement of the woad plant in France failed and by 1737, the penalties for using indigo were removed and indigo was an established trade in Europe.

Indigo in England

In 1608, England learned the art of indigo dyeing and in the reign of Queen Elizabeth its use was permitted along with woad. But opposition to its use was so strong that it was again prohibited on the pretext of being poisonous and in 1660, Charles II, had to procure dyers from Belgium to reteach the English the art of using the dye.

English East India Company

When the English East India Company began persistently to export indigo from Surat direct to England and with the increasing demand of the dye from India—the trade flourished so much—that this had the effect of stimulating the Spanish, French, Portuguese and English colonists to make strenuous efforts to extend the cultivation in various directions and to produce the dye in many countries outside India. The European colonist in America took to growing and manufacturing the dye and the improvements they effected were so great that this Indian article was no longer desired and its cultivation was discontinued in Gujarat and was never resumed in that part of the country.

Colonial Competition

The East India Company later voluntarily gave up the importation of indigo into England "in order to avoid a competition with the British colonists in West Indies and the Southern provinces of North America. About the year 1747, most of the planters in the W. Indies particularly in Jamaica, gave up the cultivation of indigo in consequence of the high duty imposed upon it." (Watt, 1908). At the same time the American colonists found that sugar and coffee had proved even more profitable in the W. Indies than indigo. The impetus was thus given for a revival and re-establishment of the Indian traffic in Indigo and the province of Bengal was selected for this revival.

Re-establishment in India

About 1778, the East India Company revived the cultivation of Indigo in Bengal and gave it direct

encouragement for the next 20 years, and India recovered her foremost rank among the indigo-producing countries of the world from which she had been temporarily ousted by W. Indies. Bengal indigo as manufactured then was the best of its kind and soon superseded all other indigo and from 1815-16, Bengal supplied all the indigo required for the consumption of the world.

For a time, the production was a monopoly of the company but as its servants were free to trade, many took to its cultivation on their own account and were so successful that they obtained permission to resign from the Company's service and became a perfectly self-supporting industry under European management—the pioneer planting industry of India.

As far back as 1801 the indigo planters of Bihar formed an association to facilitate correspondence with the Government in the interests of the community, to safeguard their interests and to deal with applications for the settlement of differences between one member and another or between members and local Zamindars and ryots. The rules were remodelled in 1837 at the instance of Government and altered in 1877 and 1905. The successful exploitation of synthetic indigo later, drove many of these planters to cultivate other crops *e.g.*, sugarcane, etc.

Troubles in Bengal and Migration to Tirhoot (Bihar)

It had no sooner been organised, however, than troubles arose in Bengal itself, through misunderstandings between the planters, cultivators, and the Government, which culminated in Lord Macaulay's famous memorandum of 1837. This led to another migration of the industry from the lower and Eastern Bengal to Bihar (Tirhoot) and United Provinces. Ultimately legislation to protect the cultivators became imperative in 1859 (Burkill 1935, Mollison 1908, Watt 1890, 1908, Hill 1937).

Woes of Bengal Peasantry under European Indigo Planters

About 1855 "3 or 4 millions of cultivators in Bengal were subjected by European indigo planters to a system of inhuman oppression which only finds a parallel in the annals of negro-slavery in America" "Every form of oppression, were put into practice by the indigo planters." (Chaklader, 1905). From the time of the introduction of indigo cultivation into the province down to its final banishment, facts prove clearly and undeniably that the ryots were forced to take up the cultivation of indigo. The immense fortunes which the European planters realised by the manufacture of indigo, did not incline them to redress the grievances of the people, upon whose labour, the success of the industry was solely dependent. This vicious state of things, continued for half a century (1810-1860), till they were unearthed by the Indigo Commission appointed in 1860, with Mr W. S. Seton Kerr, C.S. as President. The commission was instructed to take evidence and report on the whole practice of contract, cultivation and delivery of indigo. They reported "that the system on which indigo had been cultivated was a coercive system of an unrelaxing character and had broken down, because, it was, in the long run unremunerative to the cultivator". On the wake of this came the '*Nildarpan*' a Bengali drama dealing with the life of cultivators under the indigo planters published anonymously (by the middle of September, 1860) by the late Rai Bahadur Dinabandhu Mitra, when the indigo question had reached a crisis. It did immense service in awakening the mind of all classes of the Indian population and it had the same effect in helping the cause of the abolition of indigo-slavery in Bengal as Uncle Tom's Cabin had in abolishing negro-slavery in America.

An English translation* of '*Nildarpan*' with a preface by the author was circulated by the Government of Bengal. The planters denounced the drama as infamously obscene and grossly libellous. They prosecuted the printer and the publisher Rev. J. Long, an English clergyman. Mr Long was sentenced to pay a fine of Rs. 1,000/- and to serve an imprisonment for one month. The fine was paid then and there by Mr Kali Prasanna Singha, an enlightened citizen of Calcutta.

Mr Seton Kerr was punished departmentally for patronising the publication and helping the circulation of '*Nildarpan*'. Sir J. P. Grant, Lieutenant Governor of Bengal, was also similarly charged. (Mitra 1903; Chaklader 1905).

Thus ended one of the most troublous periods in the history of Bengal. Subsequently, Government enacted measures to help the indigo-planters, but the indigo interest had long been doomed and could never recover its former position in Bengal.

Hortus Malabaricus, 1686

There is no evidence of any detailed descriptive account of the manufacture of indigo in any writing prior to Rheede's great 'Hortus Malabaricus 1686' where its export from Coromandal and Negapatam is mentioned as also its production in Ceylon. Rheede figures *I. tinctoria L.* as the indigo plant, a species better suited to a moister climate than *I. articulata* Gonan grown in a large scale in Gujarat.

* '*Nildarpan*' was translated into English by Michael Madhusudan Dutt. It is said that the poet was admonished in private for this and lost his job in the Supreme Court which had been his main source of livelihood. (Bandopadhyaya & Das, 1943).

The Dutch introduced *I. sumatrana* from Malayasian region to India, a species better than *I. tinctoria*. *I. tinctoria* was taken from the old world to the W. Indies and *I. suffruticosa* was brought from America to China and the Phillippines. The Arabs took the Gujarat *I. articulata* westwards to Egypt and the Mediterranean but found on the upper Nile another suitable species *I. arrecta Hochst* and its cultivation obtained a wide extension. The ever-experimenting and alert Dutch had first given up *I. sumatrana* for the American *I. suffruticosa*; then *I. suffruticosa* to *I. arrecta* (1860) and this was what they were growing when artificial indigo was first heard of (Burkill, 1935).

Synthesis of Indigo blue: Chemical Discovery

India's position remained unassailed, though there was cultivation also on a considerable scale in Java until as a result of laborious research by Baeyer and his pupils the constitution of indigo was established (1880) and Germany found themselves at last in a position to produce indigo from coal-tar by chemical methods though manufacture, on a commercial scale was achieved in 1897. Perkin (1856) was the original discoverer of the coal-tar dyes and the first process for making synthetic indigo was patented in 1880; the method that has proved a commercial success and which enables synthetic indigo to be sold at a price much lower than that obtained from the natural product is based on a reaction discovered by Heumann in 1890, and it was put on the market in large scale in 1897. It is generally agreed that synthetic indigo obtained a footing in the market because the production of natural indigo was not brought under scientific control in time. When it came in, indigo planters were carrying on their business in old haphazard ways, neither understanding how to get good crops, nor how to extract the greatest quantity of indigo and they quickly lost the advantages which they had.

By 1905, although indigo crop was grown over considerable areas in Lower Bengal and Bihar and the output was very small, still it was the best in the world. Since then the indigo industry has been steadily on the decline owing to the increasing manufacture of synthetic indigo as mentioned above.

Indigo Trade before the Great War

Till the producton of synthetic indigo by chemical process, at a price which competed with the natural dye, the industry was thriving. Successful exploitation of synthetic indigo and decrease in the quantity of natural indigo available for export resulted in a fall in the price of Bihar indigo, which threatened ruin to these planters, who were forced to substitute other crops, *e.g.*, cultivate sugarcane and manufacture sugar.

The results were apparent for the first time in the export of 1899-1900 (Fig. 1). The average export in each decade of the 20 years ending in 1901-1902 were for the first decade *i.e.*, 1882-3 to 1891-2, 141, 811 cwt. and for the second decade *i.e.*, 1892-3 to 1901-2, 135, 396 cwt. and the average for the quinquenium 1909-10 to 1914-15 being 15,000 cwts.

A gradual decline in the export of natural indigo is further revealed by the following figures:—

Year		*Quantity*	
1899-1900	...	111,420 cwt	
1900-1901	...	102,491 ,,	
1901-1902	..	89,750 ,,	
1902-1903	...	65,377 ,,	
1904-1905	...	49,252 ,,	(being less than half the average of the previous years' prosperity).
1912-1913	...	11,857 ,,	

When in 1894-95, 237, 449 cwts. were produced from 1,688,612 acres, 166,830 cwts. were exported from Calcutta, whereas in the year previous to the last Great War, the all-India exports amounted to 10,939 cwts. of which 8,752 cwts. came from the factories of Bihar.

Until 1907-08, indigo represented more than half the total value of dyeing and tanning materials exported. This percentage had fallen to one-fifth in 1913-14, but had recovered its old position the following year (1915-16).

The province which continued to contribute chiefly to the foreign export trade before the war was Bihar, where the dye was more systematically extracted and marketed under European supervision.

The inferior indigo of Northern India and Madras, manufactured in factories on indigenous methods, continued to serve a purpose and is still being continued, much of it being used in India, but this industry is of small importance compared with that of Bihar.

At one time it was hoped that the introduction of Natal Java plant (*I. arrecta*), giving a higher yield of indigotin with improved and cheaper methods of cultivation and extraction might stem the tide, but retrogression proceeded steadily until the declaration of hostilities in 1914 closed the markets of the world to the synthetic substitute. By 1910, Java industry was dead (the Phillippine industry had been abandoned before 1900) and in 1913-14, the area under cultivation in India was scarcely more than a tenth of that in 1895-96 (Fig. 1).

Since the introduction on a large scale of synthetic indigo efforts have been made in India and in Java to place the cultivation of the plant and the manufacture of the natural indigo product on a more scientific basis. But although many important improvements have been achieved from the agricultural as well as from the manufacturing point of

view, resulting no doubt in the retention of a portion of the industry, the synthetic product has continued to gain the upper hand.

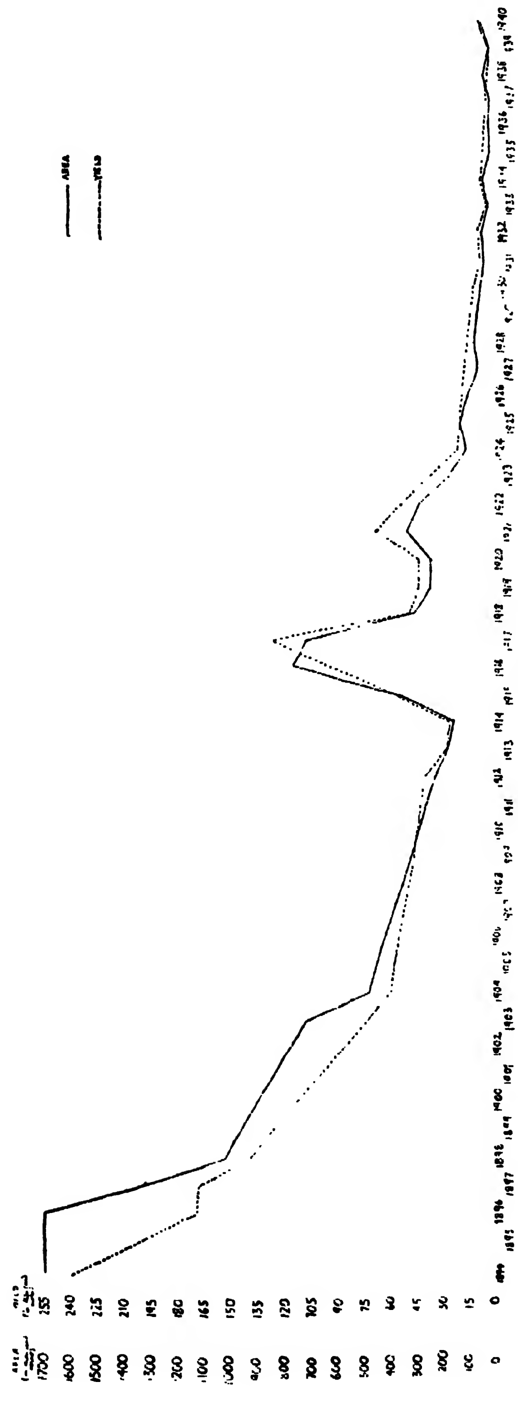

Fig. 1

Great War and Indigo

Soon after the outbreak of the last Great War (1914-18) supply of synthetic indigo from Germany was cut off and the shortage of dye-stuffs among the Allies became acute, and in India, when the Calcutta indigo sales were resumed in December, 1914, the prices realised were nearly four times as great as those of previous March. This gave a temporary stimulus to indigo growing in India, Java, China and Japan.

The feature of the export trade in 1915-16 was the heavy shipment from Madras, greatly in excess of those from Bihar, which went chiefly to the United Kingdom, and also to Egypt, Persia and U. S. A. In recent years (1939-40) an increasing participation by Greece is noticeable with Egypt and Yugoslavia coming next in importance.

With the encouragement to exporters and with the Indian dyers finding supplies of aniline increasingly difficult to obtain and then only at extravagant rates, the area under indigo in India increased 3½ times in 1916-17 (Fig. 1) as compared with the preceding five years. But even then the total acreage was less than half the high water mark reached twenty years before and the output was scarcely proportionately raised as the increase in cultivation was chiefly in Madras and the United Provinces where, the industry is mainly in the hands of small holders and the dye manufactured with simple and less costly machinery -the general quality being much lower (40 to 50 p.c. indigotin) than the Bihar quality (60 to 70 p.c. indigotin).

A reaction had set in even before the armistice. The dye shortage in the United Kingdom led to the re-opening of the Badische Branch Works at Ellesmere Port for the manufacture of aniline and alizarine dyes, as soon as the secrets of manufacture had been re-discovered by English chemists, and when Germany was once more in a position to export her dye stuffs freely, the competition of the synthetic substitute with natural indigo became even more acute than before (Cotton, 1919, 1924: Saksena, 1937).

Indigo Trade after the Great War

In 1917-18, there was a fall in the acreage under the plant and a marked fall in prices and in 1918-19 these elements of weakness became even more accentuated.

While the area in 1922-23 was 60 p.c. above and the yield nearly double the corresponding figures for 1913-14, the loss of the Japanese market in competition with synthetic indigo resulted in a considerable decrease in the total exports. Japan took only 400 cwts. as compared with 7,200 cwts. in the previous

year. Egypt, Mesopotamia and the United Kingdom in that order were the principal recipients.

Rise and Fall of Indigo Trade

The area cultivated with their yield in cwts. and export in cwts., with the value of export and value of import of aniline and alizarine dyes are given in Fig. 1 and in the table given below.

Year	*Export of Indigo (in cwt.)*		*Value of export of Indigo in £*	*Value of import in £ of aniline & alizarine dyes*
1876-77	100,000		2,000,000	
1886-87	138,000		2,500,000	
1894-95	166,830			
1896-97	169,523	Average 135,400 cwt.	3,000,000	
1897-98	133,849			
1898-99	135,187			
1899-00	111,420			
1900-01	102,491			
1901-02	89,750			
1902-03	65,377	Being less than half the average of previous years of prosperity		
1903-04	60,000		700,000	
1904-05	49,282			
1912-13	11,857			
1913-14	10,939		141,398	699,915
1914-15	17,142	Improvement in export Average 31,000 cwt.	599,691	313,237
1915-16	41,932		1,385,795	113,808
1916-17	34,230		1,408,373	435,853
1917-18	31,062		1,018,766	652,050
1918-19	32,707		832,340	779,566
1919-20	32,687		885,068	922,870
1920-21	10,250	Average 15,000 cwt.	274,755	1,575,601
1921-22	12,362		342,457	1,947,099
1922-23	4,535		112,936	1,636,781
1929-30	867			
1932-33	342	Average 700 cwt.	5,386	1,626,560
1933-34	502		7,265	1,581,080
1934-35	544		8,012	2,053,963
1935-36			4,910	2,275,296
1938-39		Average 158 cwt.	2,733	
1939-40			1,333	81,851

Present Position of Indigo Trade

The largest area under the crop is now in Madras, contributing about 75% of the whole yield —where (as in the Punjab and U. P.) it is for the most part cultivated in small holdings and is chiefly grown by Indian cultivators and the inferior dye produced largely disappears in local consumption, though there has been a definite market for the better grades. There is also an appreciable but not definitely ascertainable area in Travancore, where *I. longeracemosa* for which a high indigotin yield is claimed, has been re-discovered (Saksena, 1937).

Trade in Synthetic Indigo

The bulk of the indigo which now comes into the European market is prepared synthetically from coal-tar. Between 1906-13 synthetic indigo captured the Chinese market by sheer efficiency and due to poorness of the Indian product. China and Japan have always been by far the largest markets for synthetic indigo, their combined consumption in 1913 being 27,000 tons (20 per cent paste) out of an estimated exportable surplus from Germany of 47,000 tons. In the same year Great Britain, British Dominions and the United States of America together took little more than 6,000 tons, China and Japan together took three-fifths of the whole of the synthetic indigo produced. "Into these far eastern markets, India scarcely penetrated in her heyday, owing to the competition of primitive indigenous manufacture, and showed little sign of capturing them in the more favourable conditions created during the last Great War, although the prosperity of the Indian industry and its ability to compete with synthetic dyes depended largely upon its being able to supply the Eastern markets" (Cotton, 1919).

Cultivation in India

In deep alluvial loamy soils and lands annually renovated with silt indigo cultivation is very inexpensive and the above conditions suit the crop best. Simple cultivation after the water has gone down followed by broadcast sowing, is all that is required. No irrigation is done in such tracts. But the best indigo is produced in highlands under a careful system of cultivation.

Deep alluvial soils in Bihar which grow indigo are deficient in phosphoric acid and nitrogen but richer in all other useful constituents. Extensive experiments in Bihar have proved that in such soils superphosphate and nitrate of potash can be economically applied.

The *Sumatrana* plants are reared from seed sown about the end of April or beginning of March. The spring sown crop yields the best dye. Plants make slow progress until the monsoon sets in when the growth becomes very rapid. By the middle of June, the plant has attained a height from 3 to 5 ft. and the first crop is ready in July, a second crop being obtained in September.

Ten to fifteen seers of seeds are required per acre. Thirty to forty bundles (a bundle weighing about 300 lbs.) is the produce per acre and the yield of dye about 12 lbs. per acre in lower Bengal and

20 lbs. per acre in Bihar (Voelcker, 1893; Mukherjee, 1923).

Extraction of Indigo—Wet Process

Indigo occurs in the leaves of the plants not as such but in the form of *Indican*—the colourless glucoside of Indoxyl and is a crystalline substance extractable from the leaves with hot water. When hydrolysed by means of certain ferments (contained in the leaves) or with dilute acids, Indican yields glucose and indoxyl, the latter being oxidised to indigotin (the colouring matter of indigo) in contact with atmospheric oxygen.

Fresh plants cut early in the morning and just before flowering (about June or July) are steeped in clean still water and macerated at 25° to 30°C for 12 or more hours in large vats made of stone. (Every 100 mds. of plant require 4,500 gallons of water). The indican undergoes fermentation under the influence of enzymes present in the leaves, with the formation of indoxyl and glucose. When fermentation is over (10-12 hours) the liquid in the steeping vats which contain ammonia in addition to indoxyl and varies in colour from bright orange to olive green is drained off into the beating (oxidising) vats placed at a lower level. The beating, the object of which is to oxidise, *i.e.*, bring the liquor as freely as possible into contact with the air, is done by mechanical means. If there is any delay in oxidation a considerable loss of colouring matter results and the indigo produced is inferior. As the oxidation proceeds the indoxyl is oxidised to dark blue particles of indigotin and the liquid has changed from a yellowish colour to indigo colour and the beating is finished. When the oxidation is complete the insoluble bluish precipitated indigo separated as blue flakes, is allowed to settle, the supernatant liquid being drawn off and run to waste. The indigo mud thus obtained is washed free from soluble matter boiled for short period with water for the purpose of sterilising, filtered, formed into bars, cut into blocks or cubes of about 3 inches square and finally dried.

Improvements in the manufacture of indigo had been brought about by Mr Christopher Rawson and by Mr B. Coventry, who by proper methods of oxidising have sometimes obtained with the help of blower for oxidising the liquid as it comes from the steeping vat—25 to 30 per cent or more of the colouring matter. With the blower, the Bihar factories sometimes obtained 12½ seers of indigo out of every 100 mds. of green plants.

The actual amount of colouring matter, indigotin yielded by the leaf is but small, averaging 0·55% which is equivalent to 36 seers of indigo out of 100 mds. of leaf but the yield from the whole plant is considerably less, since the stalks and twigs contain practically no colour. *I. arrecta* yields more indigo per unit weight of leaf and also yield more leaf than *I. sumatrana* (Mukherji, 1923).

(To be continued).

MEDICINE AND PUBLIC HEALTH

RECENT ADVANCES IN BACTERIOLOGICAL TECHNIQUE

An useful account of the recent advances in bacteriological methods has been prepared by Prof. J. Chruickshank for the British Council and published in the *British Medical Bulletin*, 1, No. 8; 1943, of which a short summary has appeared in *Nature*, January 15, 1944. The account includes the principal advances in the last ten years. The discovery of more efficient selective culture media for the isolation of bacteria, the determination of the stable subgroups or types of bacteria and the development of typing methods which ensure the detection of the probable source of an infection or an epidemic appear to be the major advances of this period under review.

The Vi or virulence antigen of the typhoid bacillus has been an important discovery which has made it clear that anti-typhoid serum made for therapeutic use should contain Vi antibodies. It has been found that the blood of typhoid carriers almost always contains these antibodies. This fact has rendered Vi agglutination test an invaluable aid to the detection of the sources of infection. Meanwhile a Vi bacteriophage which has a specific action on Vi strains of typhoid bacilli has been discovered. This bacteriophage can be used to identify particular strains of these bacilli and, as some epidemiologists have successfully tried, to trace the source of isolated infections or epidemics. Valuable results were also obtained from the typing of diptheria bacilli.

A definite advance in our knowledge of the activities of the haemolytic streptococci, the staphylococci, and the organisms of the gas--gangrene group has been recorded. Work on the haemolytic streptococci has produced evidences of the existence of thirteen groups of these streptococci. The group A streptococci, of which at least twenty-three types have been identified, are mainly responsible for human infections. It is interesting to note that the same haemolytic streptococci are capable of various manifestations. Recent researches have shown that the supposition that puerperal fever arises largely from infection of the placenta by organisms in the genital passages at the beginning of labour is untenable. The attendants, other contacts and the respiratory passages of the mother herself are to all intents and purposes the main sources of infection. Work on staphylococcus and organisms causing gas-gangrene has also made good progress, thanks to the impetus created by the war. The development of the methods of growing anaerobic bacteria in the presence of air and also on ordinary broth or peptone water containing a small strip of sheet iron represents another important bacteriological progress during recent years.

VACCINATION AGAINST TUBERCULOSIS

According to a report in *Science*, Dr Truman Squire Potter, of the Laboratory of Preventive Medicine of the University of Chicago, has shown the increased possibility of preventing tuberculosis by vaccination. The vaccine is made from tuberculosis germs that are killed by suffocating them. It has, however, not yet been tried on human beings. But the striking results of animal experiments indicate that the vaccine will prove effective in human beings as well. In his latest experiments on rabbits, Dr Potter used a vaccine from asphyxiated human-type tuberculosis germs. Of 33 vaccinated rabbits, only four showed minimal lesions of tuberculosis when large doses of virulent germs were injected into their veins after the vaccination. Of 33 unvaccinated rabbits, 25, including three that died, showed frequent severe lesions.

Vaccines against tuberculosis have in the past been made either from living but weakened strains of the germs or from germs that were killed by heat or chemicals. None of these has been generally accepted as safe and effective, although promising results have been reported with B.C.G. vaccine, made from living, attenuated tubercle bacilli.

The suffocation of the tuberculosis germs must be done under carefully controlled conditions which include an absence of oxygen, presence of moisture and a temperature high enough to keep the germs' metabolism active. Under these conditions the germs die partly as a result of self-sabotage. By continuing their living processes they deprive themselves of oxygen as they breathe, and since no more is supplied them, they suffocate.

Destruction of the germs by this method, Dr Potter believes, is less likely than other methods to reduce or destroy the tuberculosis antigen. Antigen stimulates the body's defensive mechanism so that, when vaccination is successful, the body defences are ever on guard in suitable strength to overcome fresh invasion of the germs that produce the antigen. This is the principle of vaccination in general. In the case of tuberculosis, the problem has been to find a way of getting enough antigen into the body to develop immunity without giving so much or giving it in such form, for example in living germs, that it will cause tuberculosis.

PENICILLIN FOR WOUNDS

Results of penicillin treatment of infected wounds in U. S. Army hospitals are summarized in a report by Major Champ Lyons, M.C., A.U.S., according to a report in *Science News Letter*.

Penicillin can produce "dramatically successful" results in treating septic gun-shot fractures but, Major Lyons emphasized, its position is supplemental in the overall surgical programme. To get these dramatically successful results, the surgeon must combine penicillin with effective blood transfusions and conservative surgical procedures according to the condition of each patient.

Important advantage of penicillin is that it helps to fight anaemia in chronically infected battle casualties. Part of this seems to be due to the increased appetite the patient develops while under penicillin treatment, enabling him to eat more blood-building food, and part to the fact that penicillin controls the infection.

This regeneration of hæmoglobin, the blood's red colouring matter, proceeds too slowly under penicillin treatment alone, however, in view of the need to economize on penicillin and to reduce the time the patient must spend in the hospital. Consequently blood transfusions must be resorted to. Whole blood is best for this and the quantities needed for each patient are estimated at from one and one-half to three quarts.

The results reported by Major Lyons cover experiences with penicillin in 11 Army hospitals where every detail of the treatment was studied with great care so that as much as possible might be learned about the drug, effective doses, conditions that would be helped and those that would not, and the like.

MALARIA IN BENGAL—A SCIENTIFIC PROBLEM

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THE author in his professional capacity as Malaria Engineer to the Government of Bengal has often been confronted with a common question as to whether his qualifications were that of a medical man or an engineer. Learned professors, engineers, doctors, lawyers—all kinds of men have expressed their astonishment in the knowledge that an engineer could in any way be associated with malaria. Malaria control is erroneously regarded as a monopoly of the medical profession and the popular ideas regarding malaria control are associated with quinine therapy and at best with oiling and paris-greening.

That malaria is a problem in Bengal, nay the first problem, is unquestionable. The solution of this problem requires knowledge of scientific principles which are more engineering than medical. Yet in the absence of any scientifically co-ordinated national planning, the engineers who made 'two blades grow where one grew before' have also made two mosquitoes breed where none bred before. A history of malaria in Bengal is a history of embankments for roads, railways and rivers, insufficient waterways, obstruction to natural drainage of the country and creation of innumerable borrowpits which hold stagnant water and become excellent breeding places for anopheline mosquitoes. There are three conditions to be set right if we want to solve the problem of malaria in Bengal.

Lack of Public Consciousness

That there is a lack of demand for controlling malaria in this province would be self-evident to all who would care to feel the pulse of the community. The self governing local bodies who are primarily responsible for the public health in their respective areas have signally failed to do anything. For approved antimalaria schemes of a permanent nature submitted by the local bodies (including Union Boards) the Government usually make a contribution of two-thirds of the estimated cost provided the local bodies come up with the remaining one-third and undertake to maintain the works. The local bodies have so far placed malaria control as the last item in their budget and have not been able to take advantage of Government contributions, and therefore a very considerable amount of budget money allotted by the Government for antimalaria schemes, lapses every year. It may here be emphasised that the local contributions need not necessarily be in cash but may be in kind *e.g.*, voluntary labour, and that many small schemes might be undertaken which would entail earth work, *e.g.*, in connection with re-excavation of dying streams and silted up channels, filling up of low lands and pits, etc., which could very well be done by volunteers if properly organised. One District Engineer (employee of local board) not only wanted full contribution of the entire cost of schemes from the Government but also wanted contribution for expenses of survey works before he would so much as undertake preparation of schemes which subsequently might or might not be accepted by the Government. He was not prepared to spend anything from the allotted travelling allowance budget for his overseers and subordinate staff for their going out into the fields for survey works for preparing schemes of malaria control because that sacred money was to be more usefully spent for supervision in connection with the more important public works such as construction of roads or providing more comfortable furniture and crockery for the Inspection bungalows! And this is in reference to a district which is notorious for malaria. Some other bodies are so busy with their other nation building programmes that inspite of repeated offers of technical help for preparation of anti-malaria schemes, they have found no time even to reply after the tenth reminder.

Lack of Scientific Planning

One of the first principles that a malariologist has to learn is that imitation in antimalaria work is dangerous. Every area has its own problem which requires investigations and the measures of control that are adopted must be specially suited to local conditions. Because certain measures have succeeded in say, Malaya, Java, or Ceylon there is no reason to believe that the same measures applied to Bengal would invariably succeed.

Measures have been adopted piece-meal throughout the province which show a lack of scientific planning. Many organisations are overzealous in removing jungles as an antimalaria measure. Others by applying kerosene oil to a few feet of drains and one or two tanks hope to control malaria. It may be mentioned here that without water there can not be any anopheline breeding and jungles as such do not breed mosquitoes. Not all mosquitoes are dangerous. Out of forty-three different species of

anopheline mosquitoes found in India not more than three or four species are responsible for transmission of malaria in Bengal. Others are quite harmless. Again in a particular locality not more than one or two species are really harmful. A person can not be infected with malaria unless an infected mosquitoe bites him successfully, and that drinking of water from questionable sources is never a factor in producing malaria.

From the malaria point of view this province may be divided into three, more or less distinct geographical zones.

1. *The foot hill malaria zone.*—The Himalayan foot hill zone when covered with virgin jungles is naturally free from malaria. Human interference by indiscriminate opening up of jungles for tea cultivation and establishment of colonies have very often led to intense malariousness. *A. minimus* is the vector species of anopheles responsible for malaria in these regions. Hill streams and seepage water collections exposed to sunlight and having suitable plant life for supplying food for the larvae are the excellent breeding grounds. Dense shade has been considered to be unfavourable for *A. minimus* breeding. Researches of Muirhead Thomson have established the true significance of shade in controlling *A. minimus* breeding, and removed many erroneous ideas. It has been proved that shade in itself plays no part in controlling *A. minimus* breeding, on the contrary shade is very attractive to the gravid female and the indiscriminate use of shading plants might do more harm than good. The control is entirely due to secondary effects of shade by bringing about mechanical changes. "Although *A. minimus* breeds in association with running water, in the grassy edges where eggs are laid and larvae breed is still water. Larvae of *A. minimus* are unable to resist a current of 0·29 ft./sec. The powers of resistance are not much greater than those of *A. hyrcanus* a still water breeder, and about the same as that of *A. aconitus* and *A. maculatus*. When the grassy edge of a natural breeding place is removed either temporarily by cutting or permanently by shading, the zone of still water along the edges is eliminated and there is an increase in flow The absence of still water will effectively prevent the gravid female from ovipositing and at the same time, if the water at the edge is moving faster than 0·20 ft./sec. will prevent any existing larvae from anchoring on. This velocity is the absolute maximum compatible with larval security".

It is thus seen that velocity along the edges is the determining factor in controlling *A. minimus*. Flushing the streams and channels by means of sluices or automatic syphons has been a successful measure in other countries. Here again judicious care and planning are required for achieving successful results. The author has come across several sluices and automatic syphons installed over hill streams, which are complete failures due to lack of proper design and selection of site. There was one sluice whose foundation was not deep enough and had consequently been scoured to such an extent that water was passing below the foundation to the downstream and leaving the whole structure like a more or less hanging wall. No water could accumulate in the upstream side and consequently there was no flushing. The sluices were put in wrong positions and even if they were working properly, only a very small length of the river bed down-stream could have been properly flushed owing to numerous bends and zig-zag course of the river. In such cases it is essential first to train the river by straightening out the bends, and putting in smooth curves where absolute straightening is not possible. During the early stages of river training it will be necessary to put in protective works at points where the new alignment would deviate from the old one, because the river will have a tendency to retrace its original course such straightening of the course would lead to a greater velocity which would manifest itself in tending to scour away the bed and keep it more or less free from excessive deposition of silt. This will considerably reduce the work of the maintenance gang. A greater velocity provided the edges are kept clean, would in itself be an excellent and immediately successful anti-malaria measure against *A. minimus*. After the river has been trained as far as possible it would be possible to locate the exact suitable positions for sluices, if at all found necessary. It is always a good plan to instal only one sluice to start with and watch the results. On the basis of its working additional sluices may be added with any modifications found necessary.

Subsoil drainage may sometimes prove suitable in dealing with seepage water, in such regions.

2. *Inland Plains—Deltaic Regions.*—Stretching from the southern extremity of the foot hill zone down to the coastal regions, is the area where *A. philippinensis* is the principal vector responsible for transmission of malaria. There is no exact line of demarcation between this area and the foot hill zone. *A. minimus* has been found to be a vector in the district of Jalpaiguri and even down to Rangpur. *A. philippinensis* generally breeds in clean water tanks, ponds, borrowpits etc. The numerous tanks and pools of which there is an average one per holding, are excellent breeding places. The species does not generally breed in polluted waters and prefers more or less sunlit areas. Paddy fields in general are harmless so far as this particular species is concerned.

Observations in one research station extending over a considerable number of years have shown the innocuousness of the paddy fields. It has further been found that not more than 3 to 30% of the breeding places (tanks and pools) breed the particular species at any one time. This gives an excellent possibility for 'species sanitation' because a large majority of the breeding places may be altogether neglected based on a searching and regular weekly larval survey of all the breeding grounds. This results in a considerable saving of larvicides, and the author has successfully applied this method in another experimental station.

Oil, parisgreen, or any other larvicide or insecticide, however cheaply applied, is however no solution for Bengal malaria. Flushing the land with silt laden flood water in the deltaic areas appears to be the only cheap, permanent and successful method. This aspect has been clearly dealt with by Dr Bentley. Formerly the deltaic rivers when they were unfettered and free from human interferences like embankments used to spill over their banks during the rainy season. The rise in flood level was gradual and the flood water used to flush the whole country from field to field which ultimately became a vast lake of water. The flood water also entered the numerous tanks, pools and pits. This silt water is inimical to anopheline breeding, or more correctly it created conditions which were unfavourable for anopheline breeding. Silt which is a natural manure used to deposit in the fields and enrich the soil, and clear water used to drain out subsequently through numerous rivulets and channels. This annual flushing not only kept the country free from malaria but also enriched its agriculture. Of course there were temporary inconveniences due to such flooding but the floods were never so disastrous as we experience now-a-days. Owing to putting up of embankments the rivers can no longer overtop their banks and the silt that used to be deposited on the land and thereby gradually raise its level, is now deposited in the bed of the river itself. The result is that the river bed is continually rising but the country level remains the same so that the embankments have to be raised higher and higher to protect the land against flood. The land becomes devoid of the rich fertilising silt which results in deterioration of agriculture so much so that the yield per acre in Bengal is now approximately one-third of what it is in other countries.

Controlled irrigation with flood water or flood flush drainage schemes where possible would certainly solve the malaria problem. The malaria problem in this region is mainly an irrigation and river problem.

Fish plays another important role in controlling malaria. It is the small fry which are more helpful in this respect but the people are so poor and ignorant that even these small fish are caught in plenty for use as food.

3. *Coastal Regions and Tidal Zones.*—In the coastal regions and tidal areas the vector species responsible for malaria is the saline water breeder *A. sundaicus* In the tidal zone where the saline tidal water during spring tide can get through creeks and canals into nearby tanks and pools or other water collections, conditions are created which are most suitable for the breeding of *A. sundaicus.* During the spring tide saline water may enter into remote areas which unless flushed by daily tide increase in salinity owing to evaporation of certain amount of water for a fortnight. Such water collections, with appearance of aquatic vegetation, become favourable breeding places for *A. sundaicus.* This species has the fixed habit of breeding in the water collections which are reached by the spring-tide but are not flushed by the daily tides. Hence the rational method of control of *A. sundaicus* would be either (*a*) to completely prevent the tides from getting into water collections and low lying lands or (*b*) to bring the area completely under the daily tidal influence of the river or sea. There should not be any compromise between the two. The flushing channels should be provided with sluices so that the entry of tidal water into them during flow tide, or drainage from the countryside during low tide, may be controlled at will. The entry of saline water into remote areas can be prevented by keeping the sluices completely closed during spring tide.

The designs of flushing channels require careful consideration. These flushing channels should serve the dual purpose of flushing during the high tide and draining during low tide. For purposes of designing drainage channels, the usual run-off for this part of the country is taken as ¾″ per day. Knowing the catchment area to be drained the required discharge for drainage alone can be determined. The figure must be increased to take care of the amount of additional tidal water that would be admitted into the canal for flushing during flow tide and which will have to be drained out during low tide. From the slope of the proposed canal (slope is determined by the ground levels) the necessary width and cross section of the canal can be designed.

If V = velocity of flow in feet per second; C = a coefficient of discharge; A = area of cross section of channel in square feet ; p = wetted perimeter of the channel in feet; r = hydraulic radius $= \frac{\text{Area of section}}{\text{Wetted perimeter}} = \frac{A}{p}$; S = hydraulic gradient or slope of channel $= \frac{\text{Difference in level}}{\text{distance}} = \frac{h}{l}$, h = fall in feet between points considered, l = distance in feet between points considered ; then $V = C\sqrt{rs}$, and Q = discharge in cubic

feet per second (cusec) $= AC\sqrt{rs}$. The coefficient C can be determined from Kutter's formula

$$C = \frac{41\cdot65+\frac{0\cdot00281}{S}+\frac{1\cdot811}{n}}{1+\left(41\cdot65+\frac{0\cdot00281}{s}\right)\frac{n}{\sqrt{r}}}$$

where n = coefficient of roughness which varies with the nature of surface of the channel. For straight and uniform earthen channels in fair condition 'n' may be taken as 0·025.

Example.—A proposed channel is to drain an area of say six square miles and also serve as a flushing channel for flushing the adjoining area with tidal water. The slope of the channel as determined by the ground levels and the water levels of the river from which it is to be flushed with tidal water during flow tide, is 1 in 2,500 (*i.e.*, a fall of one foot in a length of 2500 feet). Taking ¾" per day as the run-off, the required discharge would be, 6 square miles $\times \frac{3}{4}\left(\frac{1\times5280\times5280}{12\times24\times60\times60}\right)$ cubic feet per second $= 6\times\frac{3}{4}\times27$ (1 inch per square mile per day is equivalent to 27 cubic feet per second) = 121·5 cusec. Allowing for a flood water of say 80 cusec the total required discharging capacity of the channel would be about 200 cusec. If the depth of water in the channel is to be say 4 ft. and side slopes of 1¼ : 1, then a channel with a bed width of 16 ft. would meet the present requirements. This channel would give a maximum discharge of 206 cusec as can be found out by applying the given formula. In actual practice it is not necessary to make all the detailed mathematical calculations, as ready-made discharge tables and charts are available for varying conditions of flows.*

LACK OF CO-ORDINATION

Malaria in Bengal is in a large measure due to man-made causes. The Intergovernmental Conference on Rural Hygiene (1937) pointed out that although in some Far Eastern countries a fair degree of co-operation had been developed between health officers and engineers for the avoidance of malaria, yet the engineer-made malaria in other countries was appalling. Such malaria was 'due to improper siting and housing; indiscriminate aggregation of labourers; uncontrolled jungle clearing, excavations such as borrowpits, brickfields and quarry pits; obstruction of natural drainage by road, railway and canal embankments, with culverts too few and too high; impounding of water without regard to leakages, seepages and raised water table levels; irrigation without drainage'. These causes equally apply to Bengal.

Public Works and Public Health Departments, engineers and medical-*cum*-public health workers in the past used to work in more or less water tight compartments. Much ground-work has been done in Bengal to co-ordinate the activities of the different departments, and engineering schemes inaugurated in the province are first examined by the Public Health Department to ensure that they do not adversely affect the health of the country. Instructions have been laid down for the guidance of the various departments in matters affecting public health with a view to controlling malaria in this province. Much more yet remains to be done. The lack of education and public health consciousness amongst the mass are the serious obstacle. While measures might be adopted for controlling malaria in an area, practically nothing can be done to prevent the people from creating further insanitary conditions *e.g.*, by digging more borrowpits or *dobas*. Of course the Union Boards and local bodies have got sufficient legal powers to enforce public health principles if they seriously want to apply them, but it is rarely done, as in that case the next elections would probably see them out of office. Russel dreams of a golden age in which 'all civil, electrical and irrigation engineers in malarious countries will have some training in public health and specially in malariology as related to their own profession'. Medical officers should also turn more readily to engineers for technical help.

RATIONALE OF PLANNING MALARIA CONTROL

Malaria control for a country must proceed on three different and distinct stages.

Phase I—Investigation.—Medical men should make a survey of the malaria situation and state the extent of malaria in the locality.

Phase II—Scientific Research.—Biologists aided by chemists and physicists should carry on research and studies about the habits of the vector and it is for them to evolve a problem, and a sane and practical problem, which if solved would eliminate either wholly or sufficiently the anopheline vector.

Phase III—Execution.—Engineer should now step in to take up the problem and find out means for solving the problem. As an example, when the biologists at Durrazzo found out that if the salt content of the marsh could be increased to more than 18 parts per 1000, '*Elutus*' the dangerous type of mosquito for that locality would not breed in that water, it was then for the engineer to find out a method of doing it, and he did it successfully.

What then are the known problems in Bengal, and what are the probable answers?

* The data are n t sufficient to be convincing. Workers in the line may not agree with all the assumptions made.—Ed. *Sci. & Cul.*

1. Foot Hill Malaria—*A. minimus* zone.

Problem.—Increasing the velocity of water to more than 0·29 ft. per second and *A. minimus* would not breed.

Solutions.—(*a*) Cleaning the edges free from vegetation—immediate results; (*b*) Dense and complete shading; (*c*) Flushing after training the rivers: (*d*) Subsoil drainage to a limited extent.

2. Inland Plains—*A. philippinensis* zone.

Problems.—(*a*) Deltaic area:—Silt laden water inimical to anopheline breeding. Bentley has shown with numerous facts and figures that in the deltaic regions of Bengal (when the flood water was unobstructed) the prosperity of the people and the absence of malaria were due to a system of irrigation which flooded the land with silt laden water. Even in Egypt the red water carrying silt is associated with prosperity and the white water with malaria and lesser yield of crop. How silt water is inimical to anopheline breeding is not definitely known. Bentley has given several reasons which however can not be taken as conclusive. Much information in this respect is lacking compared to research work done in Italy. Very little is known about the varying silt contents of the different rivers and the degree of turbidity which is most suitable for the purpose of malaria control. Nor do we know exactly (notwithstanding possible reasons given by Dr Bentley) how silt acts as a deterrent. If more exact knowledge were available in this respect, engineers could have offered more satisfactory solutions. Here is a vast field for study and research by scientists.

Solution.—Flushing with silt laden water diverted from the rivers by means of channels and by reviving the natural processes.

(*b*) High lands—Non-deltaic regions: In many areas there is no possibility of flood flushing yet the malaria problem is very intense. The tanks and pools are the major breeding places. We know very little, practically nothing, which would help in offering a cheap and satisfactory solution. Here is another big field for research workers.

Solution.—Oiling or paris-greening, cleaning the tanks, herbage packing, insecticidal spray etc. and such other expensive methods can do doubt lead to success, but poor Bengal cannot afford it. Fish seems to be the only cheap solution but in this also there are many difficulties. Will the scientists give us a definite problem to solve?

3. Coastal Areas and Tidal Zones—*A. sundaicus* zone.

Researches so far have not given any definite range of salinity in which *A. sundaicus* would breed. It is said to be adaptable to wide range of salinity from very low to very high. Combined with this is the problem of irrigation. Paddy will not grow in water having a salinity over 75 parts per 100,000. Certain types of crops can resist a maximum of salinity of 200 parts per 100,000. The agriculturalists in these areas have put in marginal embankments for excluding saline water from entering into the fields. The results have been that the rivers can not have a free spill. Water remains stagnant in the country side, and stagnant saline water is an excellent breeding ground for *A. sundaicus*. Restoration of free spill would of course control malaria but the crops would at the same time be damaged. Here is a wide field of research for agricultural experts to find out a crop that would acclimatise itself to higher ranges of salinity. Here is a problem in which the interests of the cultivators and public health are at variance which the scientists may try to accommodate. Abandonment of rice cultivation and development of pisciculture would no doubt be a solution but that is not likely to be within the range of practical politics.

Malaria is Bengal's curse. It is the one problem that led to many, one that has crippled us, sapped our vitality and given rise to utter despondency which is about to ruin our very culture. It is a formidable foe which no single effort can control. The difficulties are that we are much behind in the development of *Phase II* of malaria control on which the greatest amount of stress must be laid by scientists and research workers. It is a proved fact that given sufficient funds malaria can be controlled in any locality. But where are the funds? Oil or Parisgreen or any insecticide applied however efficiently and cheaply, is no solution. Poor Bengal can not afford to finance such recurrent expensive schemes to combat rural malaria. It is here that the biologists and scientists must come in and find out some naturalistic method of control which would be sound from practical as well as financial points of view.

Let us all join hands and offer our humble mite. Here then is a great circle where the medical men can freely join hands with the engineers and with no less glory the scientists of all shades—Chemistry, Physics, Biology, Agriculture; and also Educationists and Financial experts.

BOOK REVIEWS

Social Studies and World Citizenship—By L. J. F. Brimble *and* F. J. May. Macmillan & Co., 1943, xii, 158. Price 6s net.

"However people may disagree about the form that the new social order will take, all agree, though often vaguely, that 'things will never be the same again'. With the changes in the social order, changes in the educational world will come simultaneously, and when changes are inevitable, it is incumbent on those who have long wanted and worked for reform to be ready with clear ideas on the forms these changes should take." The book opens with this refreshing preamble. "Things will never be the same again" indeed. Wars are notoreously devoid of anything constructive in the sphere of ideas; but this war, unlike the preceding ones, has vigorously shaken the age-old inertia in the fighters, in the front as well as in the rear. What are we fighting for? they ask. Are we fighting for our betterment or are we to be enlisted once more in the post-war unemployment brigade? And precisely this trend in their thinking will be mainly responsible for the shape of things to come in the peace time. Similarly, in the years to come those who are keenly interested in social problems will feel indebted to the writers who are arduous enough to go deep in search of the bases on which our society is built and also bold enough to face themselves and expose before their readers the facts as they are. New paths in social studies can now be explored only when the classic view of the society as being static is given up and writers begin to realise that society must be studied in its proper perspective of dynamic background.

Once this 'academic tradition' is broken the writers could be made to see the futility in studying society ignoring contacts with the people around him. This conclusion would bring them a step nearer to the stern reality that social studies can only be considered thorough when its economical environment is given the proper place. Quotations are not necessary to prove that social behaviour in Arabia is different from that in U.S.A. and definitely not the same as in the U.S.S.R. A boy who has faced starvation in his childhood would obviously manifest features characteristic to his class differing extensively from one born with proverbial silver spoon in his mouth. It is simple enough to distinguish the members of a feudal zemindar family by their manners and customs from those of wage earners or industrial magnates. Vices and virtues in an individual or a nation are too closely connected with the problems related to bread and butter. Repugnant though such a notion may be to the sophisticated writers in matters ethical they are, nevertheless, true as conclusively proved by the recent empirical investigations.

Whatever the final analysis of the social structure may be, lack of critical attitude of the writers make most of the books meant to be social studies mere superficial studies. A similar limited vision has led the writers to believe that "Many agencies which can actively foster world citizenship are already in existence; for example, the International Postal Union, Red Cross Organisation, Travel Science, League of Nations, International Bureau of Education . . . ." But then the League of Nations and the hosts of International Bureaus, which in the writers' judgment are temples of peace, could not prevent the war, neither any sane person would expect anything better in future not unless the poisonous root of exploitation of one nation by another is exterminated for ever.

It is amusing to note while discussing at length the topic World Democracy the writers have reprinted from *The Times* a letter from an aviator in the R.A.F. written to his mother, ". . . History resounds with illustrious names who have given all, yet their sacrifice has resulted in the British Empire, where there is a measure of peace, justice and freedom for all, and where a higher standard of civilisation has evolved, and is still evolving, than anywhere else . ." In the opinion of the writers the aviator is "a type which we as teachers together with the parents of our children, must aim at developing for the generations to come." I wonder if the writers mean to build world democracy on the foundations of which they have unconsciously given us a glimpse!

The writers share in the belief pathetically held by most of the ardent educationists that "The failure to teach the fundamentals of the international relations is due either to an innate aversion to teaching such material, or more probably the inertia of educational leaders has kept it out of the curriculum." Under the existing circumstances prevailing in the five-sixth part of the globe education is controlled by the State directly or indirectly and the aparatus of the State is in the hands of the few men at the helm, thus, education becomes a mere system through which the will of these handful of people prevail,

and no amount of enthusiasm expressed by the educational leaders could alter the state of things.

The book opened with a statement which is in harmony with the changing world, and as one turns the pages coming to the close of the book he would be naturally led to conclude 'all that glitters is not gold'.

N. P. M.

Technical Education—By J. C. Ghosh, B.Sc. (Manchester). Preface and Introduction—95 pages, main body of the book—152 pages. Appendices—156 pages.

The book is a collection of different articles by the author published in some daily papers and journals. Main theme is the utility of and necessity for technical education in India and an earnest appeal to the people to go in more for technical and vocational training for their own economic interest and industrialisation of the country. Such appeals might have been necessary 40 or 50 years ago ; the present day problem is the establishment of sufficient number of institutions for technical and vocational training of all kinds and standards to provide for all young aspirants after such lines of training, but one should remember that technical education alone cannot industrialise a country ; it simply supplies the personnel for the production side of the industres ; a technically trained person is not necessarily a good business man. Moreover under the present world conditions a good and stable national government is a pre-requisite for the industrialisation of a country which cannot be effected piecemeal.

H. L. R.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*

PECTIN IN FRUITS OF THE INDIAN PERSIMMON (*D. EMBRYOPTERIS*, PERS.)

A hot water decoction of the mature fruits of the Indian Persimmon finds an extensive application in the seasoning of the fishing nets and in applying as a paint on the country boats. While searching for new indigenous raw materials for tannin I turned my attention to this common fruit (Gab). It contains a pyrogallol tannin but great difficulty was experienced in the isolation of it in the pure state in as much as the extract obtained in the usual way when dried on steam-bath turns insoluble in water. While trying to purify it by the addition of alcohol to a concentrated extract of the stuff, voluminous gelatinous precipitate appeared which when carefully washed did not give the usual tests for tannin but it responded to the tests for pectin.

Another method was also found very suitable for the separation of this stuff from the concentrated aqueous extract. On the addition of hydrochloric acid to the above mentioned extract the pectin separates out which can be washed with water and dried. As the fruits appear to contain a high percentage of pectin (about 50% of the weight of the fruit) and the fruits are obtainable in great abundance at a low cost it may form a very good sizing material in the textile industries.

Work is in progress in this laboratory for the isolation of pure tannin and pectin from the Indian Persimmon.

H. G. Biswas

Sir Prafulla Research Laboratory,
Bengal Chemical & Ph. Works Ltd.,
Calcutta, 3-1-1944.

MEASUREMENT OF CAPACITANCE

The note describes a modification of the De Sauty's bridge for measuring capacitance of the order of 1 $\mu\mu$ Fd. at audio frequencies instead of taking resort to radio frequencies and radio methods.

The well known Carey Foster's A. C. bridge[1] fails to measure capacitance of the order of 1 $\mu\mu$ Fd. at telephonic frequencies. Instead of trying with the radio frequency methods a modification of the simple De Sauty bridge has been tried in this laboratory.

Hartshorn[2] has described a modification of the schering bridge where the voltage applied has to be stepped up gradually in order to attain the requisite sensitivity at balance. Moreover it is only applicable

in the case of perfect condensers of the order of 1 $\mu\mu$ Fd.

This modification of the De Sauty's bridge[3] enables us to measure capacitance of the order of 1 $\mu\mu$ Fd. in case of imperfect condensers too. The electrical connections are shown in figure 1.

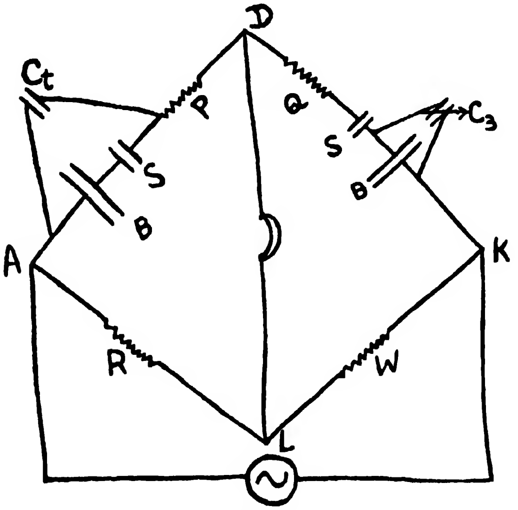

FIG. 1

The condition of balance in this network is:

$$W\left[P+\frac{1}{Jw\left\{C_t+\frac{SB}{S+B}\right\}}\right]$$

$$=R\left[Q+\frac{1}{Jw\left\{\frac{S(B+C_3)}{S+B+C_3}\right\}}\right]$$

If $W=R$, we have $P=Q$ by equating the reals; and equating the imaginaries we get

$$C_t+\frac{SB}{S+B}=\frac{S(B+C_3)}{S+B+C_3}$$

$$\therefore C_t = SB\left\{\frac{1}{S+B+C_3}-\frac{1}{S+B}\right\}+\frac{SC_3}{S+B+C_3}$$

$$=\frac{-SBC_3}{(S+B+C_3)(S+B)}+\frac{SC_3}{S+B+C_3}$$

$$=\frac{-SBC_3+SC_3(S+B)}{(S+B+C_3)(S+B)}$$

$$=\frac{S^2}{(S+B+C_3)(S+B)}=\frac{S^2}{(S+B)^2}C_3 \text{ approx.}$$

because C_3 is small in comparison with $(S+B)$. Thus the value of the test condenser is $C_t=\left\{\frac{S}{S+B}\right\}C_3$.(A)

In each of the arms AD and DK of the bridge S is an air condenser of capacity 0·001 μ Fd. and B is a standard variable mica condenser (dial pattern) of value 0·009 μ Fd. C_3 is a continuously variable air condenser ranging from 50 to 1000 $\mu\mu$ Fd. The resistances R and S are each equal to 1000 ohms. P and Q denote the effective resistances of their respective branches. The test condenser is joined in parallel to the two condensers in the AD arm so that its capacitance is directly additive. The DK arm is symmetrical with the first except the addition of a variable air condenser C_3 in parallel to the bigger condenser B only. If C_3 is changed by 10 $\mu\mu$ Fd. then it will be seen from equation (A) that the capacitance of Q branch is changed by $\partial c=\frac{1}{100}\times 10=\cdot 1$ $\mu\mu$ Fd. Now for example if the capacitance of test condenser is 1·3 $\mu\mu$ Fd. then the dial reading of variable air condenser C_3 has to be changed by 130 $\mu\mu$ Fd. and is directly determined by making an allowance for the capacitance of the connecting leads of the test condenser.

The bridge though apparently symmetrical is not perfectly symmetrical and hence there is some difficulty in obtaining a perfect balance as detected by the telephone. The test condenser is in parallel to B and S in AD arm while the variable air condenser is in parallel with only the bigger condenser B in the arm DK. Hence extra resistances have been introduced in P and Q branches in order to have a balance of the phase as well. The resistances have to be adjusted for every reading of variable air condenser C_3 and thus the difficulty in obtaining a good balance is overcome.

The self capacity and inter-capacity of the connecting wires becomes a source of trouble which has to be overcome by proper shielding and earthing devices. The relative positions of the connecting wires should not be changed during one set of observation. These modifications enable us to measure such low order capacitance at telephonic frequencies without much trouble.

The author is indebted to Dr R. C. Ray and Prof. L. M. Chatterji for the theoretical discussions and practical suggestions.

B. K. SAHAY

Science College,
Patna, 2-3-1944.

[1] *Phil. Mag.*, *23*, 121, 1887; *Ann. Physik.*, *53*, 499, 1894.
[2] *Proc. Phy. Soc.*, *36*, 1924.
[3] Electrical Measurements—Hams.

X-RAY STUDIES IN JUTE I. PRELIMINARY OBSERVATIONS

THE importance of X-rays in inducing germinal changes in living organisms has been recognized since the publication of the classical experiments of

Muller[1] on *Drosophila*. Subsequently a number of investigators have experimented on the application of this technique in plants and have discovered that mutations could be induced in this way. The cytological and genetical changes accompanying this phenomena have been classified under translocations, inversions, duplications, deficiencies following chromosome breakage and gene mutations. Most of the mutations so induced are useless and inviable from the Plant Breeder's point of view due to the unbalanced nature of the chromosome complements. But it is possible to create a number of abberrant types that may be used in analysing the genetic constitution of the species. At the same time there also remains the remote possibility that mutations favourable to plant growth and development might also be produced. With these aims in view, the following species and varieties of jute were x-rayed.

1. *Corchorus capsularis* var. D. 154.
2. ,, ,, ,, D. 386.
3. ,, *olitorius* ,, Chinsurah Green.
4. ,, ,, ,, R. 26.

The seeds were packed in the dry state in small cylindrical card board containers and exposed to x-rays at a target distance of 17 cms. The tube current was about 4 mA, operated at 30 kV. Each variety was exposed for 1, 2 and 3 hours.

The treated seeds were sown at the Experimental Station of the Bose Research Institute, Falta, in rows, with a spacing of 6″ between plants and 1 foot between rows, with a control in each plot. A total of about 4000 plants were grown and their morphological peculiarities noted from time to time. Some of the treated plants developed branches at various heights from the ground, even from the early stages. Complete growth data was collected with special reference to the height, basal diameter, size of leaves, and heights and number of branches if any, from the ground. The nature of the pigmentation of the stems and leaves was also noted.

In *C. capsularis* var. D. 154, one of the treated plants grew up to a height of 17 ft. with a basal diameter of 1·9″ and without any lateral branches. Basal diameters as much as 2½″ were recorded in the treated plants of this variety. The controls on the other hand had a height of 7-9 feet with a basal diameters of about ½″ only.

A number of plants with good heights and basal diameters and without side branches were isolated from the above 4 varieties. The full details, including a cytological analysis of the morphologically interesting plants will be published in due course.

Seeds of the plants showing interesting deviations from the normal, were collected and will be sown in this season to study their subsequent behaviour. In addition to x-rays, the effects of neutrons, ultra-violet rays and gamma rays in inducing mutations in the above varieties will also be tried during this season.

It is also hoped, that by upsetting the genetic stability by irradiation, interspecific hybridization may be possible, as attempts to hybridize the two species in their normal state have not so far been successful.

I am indebted to Dr J. S. Patel, Director, Jute Research Laboratories, Dacca for the seeds.

My thanks are due to Dr S. C. Sirkar, Indian Association for the Cultivation of Science, Calcutta, for x-raying the seeds.

K. T. Jacob

Cytogenetical Laboratory,
Bose Research Institute,
Calcutta, 11-3-1944.

[1] Muller, H. J., 1927. "Artificial transmutation of the gene". *Science*, *66*, 84-87, 1927.

STUDIES ON THE PHYSIOLOGY OF JUTE

The authors are engaged in a study of the fundamental aspects of the growth and development of the two species of jute: *C. capsularis* (D154) and *C. olitorius* (Chinsura green) and a brief report of some of the experiments done in 1943 growing the plants in suitable pots under statistical design is given below:—

(1) *The effect of the time of sowing.* Seeds were sown at intervals of 15 days, there being 5 sowings of *C. capsularis* from 15th March and 4 sowings of *C. olitorius* from 30th March. It was seen that as the sowing was delayed the vegetative phase was reduced except in the case of the 1st sowing of *C. olitorius* on 30-3-43 which flowered abnormally early after 51 days and the 2nd sowing of *C. capsularis* on the same date, which also flowered rather early after 109 days, the vegetative periods for the five successive sowings of *C. capsularis* being 145, 109, 117, 112 and 96 days and the same for the four successive sowings of *C. olitorius* being 51, 128, 117 and 103 days. As the sowing was delayed it was found that in both the species the rate of growth in length increased, but there was no marked difference in the final height which varied between 10 and 12 ft., except in the abnormal case of 1st sowing of *C. olitorius* (which had a height of 4′ 10″); lesser number of internodes and leaves were produced, branching was reduced and the shedding of leaves from base were hastened. For all the different sowings flowering dates came very close to each other, *viz.*, be-

tween the 7th and 18th August in *C. capsularis* and 20th and 26th August in *C. olitorius*.

Off season sowings in winter (October to December) shortened the vegetative phase and the plants remained very short with very few internodes. Sown on 28th September the plants flowered after 36 days in *C. capsularis* with an average height of 3 ft. and 27 days in *C. olitorius* with an average height of about 2·5 ft., the heights of normal season plants being 10—11 ft.

(2) *The effect of Photoperiod.* Sown on 20-4-43 two sets of each species were exposed to short photoperiods of 3 hours less than normal daylight, one set from the germination stage and the second set from when the plants were one month old. It was seen the 1st set of *C. capsularis* and *C. olitorius* flowered in 33 and 28 days and the 2nd set in 47 and 44 days and the control in 114 and 125 days respectively, the earliness in flowering being 81 and 67 days for the 1st and 2nd set of *C. capsularis* and 97 and 81 days for the same sets of *C. olitorius*. Earliness of flowering was associated with dwarfness, fewer internodes and more branches, making the plants bushy.

In the winter with normal short photoperiod, further reduction of the daylight period had no effect, longer photoperiod of 16 hrs. prolonged with artificial electric light however delayed flowering, with increase in heights and internodes.

(3) *The effect of vernalization*: Soaked seeds with swollen embryos were exposed to temperature varying from 2- 5°C for 7 days and 14 days and sown with control set. No effect due to treatment on the onset of flower, height and number of internodes could be observed.

Similar experiment was repeated in winter exposing the seeds for 10 and 20 days but there too no difference due to treatment was observed.

(4) *The effect of storage*: Seeds stored for 1, 2 and 3 years were sown along with the 3 different sowings of the time of sowing experiment. Except that the 3 year old *C. olitorius* seeds failed to germinate, there was no effect of storage for 2 or 3 years on height, internodes, branching, onset of flowering etc. in the two species.

(5) *The effect of X-rays*: Soaked seeds with swollen embryos were exposed to two doses of X-ray 500 and 1500 r. units at 100 KV., 10 mil. amp. and sown with control. No difference on the rate of growth, height, internodes and onset of flowering could be seen between the control and treated plants. About 20% of plants treated in 1500 r. units remained short and the stem showed a dichotomous bifurcation at the 10th or 11th internodes generally after 5th week of sowing.

Our thanks are due to Dr J. S. Patel for the supply of pure seeds, to Prof. P. C. Mahalanobis and Mr R. C. Bose for the design of the experiments and to Dr S. Mukherjee for the use of the X-ray apparatus.

J. C. Sen Gupta
Nirad Kumar Sen

Botany Department,
Presidency College,
Calcutta, 25-3-1944.

ESTIMATION OF CAESIUM IN PRESENCE OF POTASSIUM AND RUBIDIUM WITH RARE EARTHS

The close similarity in the chemical behaviour of potassium, rubidium and caesium has led to numerous attempts to separate one from the other. In most instances, the separations are only partial and none of the methods so far proposed is in any sense quantitative. The standard methods of alkali analysis are the perchlorate, cobaltinitrite and chloroplatinate methods which precipitate all the three alkalies without any separation.

O'Leary and Papish[1] made a critical review of the various methods available for the separation of the alkali metals where they had shown that none of the methods are sufficiently accurate. They proposed an improved method for the quantitative determination and separation of potassium, rubidium and caesium based on the use in succession of o-phosphomolybdic acid (K-salt being soluble), silicotungstic acid (Cs-salt being insoluble in 6-N hydrochloric acid) and finally weighing caesium as chloroplatinate. According to the authors "The method proposed does not afford the clean-cut sharpness of separation that is desirable, though it is much more reliable than those hitherto proposed. The average error introduced in the course of the analysis by this method is two per cent.

Sarkar and Goswami[2] while preparing the triple nitrites of the rare earths $Cs_2NaR(NO_2)_6$ observed that these nitrites furnished a delicate michrochemical test for caesium, the limit of identification being 4×10^{-8} g. The test is specific for caesium; rubidium and potassium do not interfere.

We have recently observed that the reaction is quantitative, caesium being precipitated quantitatively from the solution under specified conditions and have developed a method for the quantitative determination of caesium and its separation from rubidium and potassium in one operation. The precipitate can be directly weighed in a gooch. Even 3 mgm. of caesium have been estimated accurately.

Macro quantities can be estimated with an accuracy of 0·1 per cent. Micro gravimetric and volumetric estimations are in progress.

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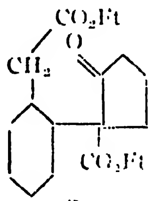
Calcutta, 7-4-44.

[1] O'Leary and Papish, *Ind. & Eng. Chem. Anal. Edi.* 6, 107, 1934.
[2] Sarkar and Goswami, *Jour. Ind. Chem. Soc.*, 608, 1935.

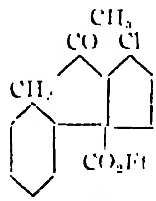
SYNTHESIS OF THE ALICYCLIC SYSTEMS RELATED TO THE STEROIDS

A few model experiments have been carried out to build up a fused system consisting of B, C and D rings with the C_{18}-methyl group and the isooctyl side-chain characteristic of the sterols, starting from cyclohexane derivatives. Ethyl methylmalonate was condensed with isohexyl iodide to give the corresponding malonic ester (122-25°/7 mm.) which was hydrolysed with sulphuric and formic acids to give ∝ζ-dimethylheptoic acid (115-25°/9 mm.). The acid chloride of the above acid reacted with diazo-methane which was subsequently decomposed with 48% hydro-bromic acid to give the bromo-ketone (103°/9 mm.). Next it was condensed with the sodium-salt of ethyl aceto-acetate kept under ether and the condensation product was hydrolysed with 2% caustic soda solution at 60°C for five hours. On cooling it was acidified and boiled for ten minutes. The product which was isolated from the reaction mixture was 2-isooctylheptane-3:6-dione (122-27°/6 mm.) and not the expected cyclopentenone derivative.

Next methylcyclopentene was oxidised in acetic acid solution with selenium dioxide and the alcohol, isolated by the known method was converted into bromide which was condensed with the potassium salt of cyclopentanone carboxylic ester. A product was isolated boiling at 130-35°/4 mm. which on hydrolysis with baryta gives 2-methylcyclopentenyl cyclohexanone (115-25°/7 mm.) in a poor yield together with a high boiling gummy product (255-40°/4 mm.). Cyclohexyl bromide was condensed with the potassium salt of cyclopentanone carboxylic ester to give cyclohexylcyclopentanone ester (140/50°/8 mm.) which was hydrolysed in a sealed tube with HCl to give cyclohexylcyclopentanone (105-107°/7 mm.) together with a highly crystalline solid residue. Ethyl $\Delta^{1:2}$-cyclohexenyl acetate was treated with bromine in tertiary butyl alcohol. Next the element of hydrogen bromide was removed with sodium methoxide when the unsaturated bromo-ester was obtained boiling at 120-25°/7 mm. It condensed smoothly with cyclopentanone carboxylic ester in presence of potassium when the product was isolated boiling at 195-200°/10 mm. Catalytic hydrogenation gave a clear colourless oil boiling at 165-70°/3 mm. (I). It was hydrolysed in a sealed tube with HCl and the free acid was esterified when the keto-ester was obtained boiling at 140-45°/3 mm. The keto-diester (I) was allowed to react with methyl magnesium iodide and the crude hydroxyester so obtained was dehydrated with thionyl chloride and pyridine to give the unsaturated ester boiling at (168-73°/1 mm.). Hydrolysis with methyl alcoholic potash gave the free acid which on treatment with P_2O_5 in benzene solution gave a ketonic product (135-45°/4 mm.) in a very poor yield. This could not be isolated in sufficient quantity but it gave a semicarbazone somewhat coloured melting at 238-42°. The free acid was converted into the chloride, which on treatment with stannic chloride gave a chloro-ketone (II) in a poor yield (140-50°/3 mm.).



(I)



(II)

Active investigations are in progress with 9-methyl ∝-decalone systems on the one side and isooctylcyclopentanone carboxylic ester serving as the second component thereby leading to the building up of the complete skeleton of the sterol type of molecules. Encouraging results have been obtained and this will form the subject matter of the next communication.

Our grateful thanks are due to Prof. P. C. Mitter for his kind interest and advice during the course of this piece of work.

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THE DAMODAR FLOODS AND AFFORESTATION

I

The commentary on a discussion by the Central Board of Irrigation, on the Damodar floods and the general problem of flood control, appearing on p. 232 of the December issue of "Science and Culture", is likely to give a wrong impression on the value of afforestation in reducing floods. I refer particularly to the remarks:—

> "The claim of afforestation as expressed in the above discussion seems to be highly exaggerated and is quite conflicting in its scientific bearing".

Apart from the use of quotations originating in 1931 and 1930 to try and disprove a statement made by a technical expert in 1943, the quotations themselves do not provide very convincing support for the commentary quoted above.

The first held that afforestation should be strongly encouraged but stated that its effect on floods was indeterminate. This was in 1931.

The second quotation read:

> "Detension dams, dykes and similar engineering measures are essential to *complete* flood control in localities where the hazard is unusually severe" (the italics are mine).

It is not my purpose to discuss the pros and cons of detention reservoirs, but it is clear that without measures such as afforestation and proper methods of cultivation in the upper catchment, to prevent soil being washed into the rivers, detention reservoirs would soon lose there value, because if the sand washed down is trapped in the reservoirs they will silt up (as has happened to several reservoirs in America), and if the sand is allowed to be carried downstream it will be a cause of floods by depositing downstream.[1] Hence the word *complete* in the second quotation, and it is clear that afforestation and proper land control are intended to be the primary measures to be taken.

Far from being exaggerated, the figures quoted at the meeting of the Board were based on data. Here are some more:

I. In an experiment it was found that more than 24 times as much water ran off from the bare area as from that covered with litter; 3500. times as much soil may be washed by rains from bare soils as from soils protected under a relatively thin cover of leaf litter.[2]

II. Over a period of seven years the average loss of water by run-off on bare, uncultivated ground, was over 40 per cent of the total precipitation, and over 15 tons of soil per acre were eroded per annum. On being veiled with a complete vegetal cover the average annual loss by run-off during the same period was 0·5 per cent. of the total precipitation, and the loss of soil through erosion was nil.

These experiments clearly demonstrate not only the vital necessity of maintaining the vegetal cover, but also the care that must be exercised in the management of arable land if losses of moisture and soil are to be kept down to any degree of insignificance.[3]

III. The following are extracts from data of run-off and water absorption for loessial soils Holly Springs, Mississippi, U.S.A.[4]

Plot	*% rainfall absorbed*	*Relative quantity of soil eroded*
Oak forest ...	99	1
Bermuda grass pasture	96	4
Barren abandoned land ...	52	3519
Cultivated cotton rows on contour ...	53	1528
Cultivated on slope ...	41	1300

While quantitative results depend to a considerable extent on local conditions, *e.g.*, ground slope, and character of soil, the enormous influence of maintaining vegetable cover, and of proper cultivation methods, on floods and soil erosion, surely needs no further proof.

Secretary,
Central Board of Irrigation.

Kennedy House,
Simla, S.W., 4-2-1944.

[1] Remarks of Mr Inglis quoted in SCIENCE AND CULTURE, 9, 232, 1943.

[2] Scott Leavitt: "The National Aspects of Soil Erosion and Floods and their Control by Vegetative cover", *Journal of Forestry*, Washington, March 1932.

[3] Union of South Africa, Dept. of Ag. & For. "Soil Erosion Control in the Union", 1938.

[4] H. G. Meginnis: "Effect of Cover on Surface Run-off and Erosion, Loessial uplands of Mississippi". (Quoted by R. M. Gorrie: "The Measurement of Soil Erosion and Run-off". *The Indian Forester.*, Dec. 1937, p. 841).

II

We have published a letter received from the Central Board of Irrigation. In connection with the various commentaries which have accumulated in course of the controversy on the relative efficiency of afforestation and flood detention dams on flood control with special reference to the Damodar, we note the following important issues:

(1) The topic is extremely controversial, opinions going to extremes; one set of authorities say that afforestation reduces the run off, while others say that it may also increase the flood tendencies (for example, Sherman Woodward, Chief Planner, T.V.A. Headwaters control and use: Upstream Engineering Conference, 1936, p. 216).

(2) Such widely conflicting results cannot be explained away without going into the details of the individual experimental conditions, and any generalisation would be unscientific.

(3) Selected laboratory or controlled field experiments cannot be accepted for generalisation of the statement that afforestation holds 98-99 per cent of the precipitation, for it is not known how far these laboratory or field measures can be actually translated to a large catchment area. It would be more honest to accept the result of the U. S. Civilian Conservation Corps which gives a maximum average retardation of 20-35 per cent only, as observed on 141 natural watersheds of the country, through the adoption of practicable erosion control methods.

Extensive afforestation, planting, terracing, dyking, etc. would obviously increase the figure for retardation of the run-off but that may not be practicable over large natural catchment areas due to the abnormal cost which may run up to astronomical figures, for, these measures amount to putting series of dams round every hill, and every sloping lands on the catchment area.

(4) Mr Glass considered the question and remarked that large expenditure on afforestation would be inadvisable for controlling the flood of the Damodar, as the heavy floods are caused entirely by heavy rainfall from 6 to 12 inches falling within 24-72 hours. In such case the soil is saturated with water and can no more retard the run-off by soaking in spite of its vegital cover. In such cases, all dams round 'hills and slopes' would give way, and floods cannot be helped.

(5) For mitigation of flood, forest cannot be taken to be equivalent to storage reservoirs as they have often been claimed to be. Professor Barrows has remarked: "Unfortunately, too, the advocates of forestry in their zeal for forest preservation often make broad and unqualified statements characterising all forests as water conservators and using this often erroneous statement as their argument to justify continued forestation, instead of allowing the worthy objective to stand, as it should, on its own merits".

(6) There is no difference of opinion regarding the efficacy of afforestation on soil conservation. Afforestation would be certainly valuable not only for conserving agricultural soil but also for the safety of the dams which should be erected for conservation and controlled disposal of the water resources of the valley.

Afforestation enthusiasts simply ignore the vast amount of work done in the U. S. A. in the prevention of floods by detention dams. Hundreds of detention dams have been constructed, are functioning properly, and floods have been controlled with the additional advantage of water control in river and on land and for the generation of electricity. Proper de-silting methods have been devised by treating the catchment areas properly, and handling the stored water scientifically. The detention dams on the erodable catchment areas (*e.g.*, The Roosevelt Dam, the Elephant Butte Dam, etc.) are functioning quite regularly and show no sign of rapid deterioration as would be predicted by afforestation experts.

Calcutta, 7-4-1944 Ed., SCIENCE AND CULTURE.

AN INTRODUCTORY NOTE ON THE CHEMICAL INVESTIGATION OF THE PLANT '*VITEX NEGUNDO*' (N. O. *VERBENACEAE*)

THE plant *vitex negundo* has been used in Indian medicine from antiquity both by Ayurvedic and Unani practitioners. We find a description of the plant together with its uses in such standard books on Indian medicines, *e.g.*, Pharmacographia Indica— Dymock, Warden and Hopper, Kirtikar Bose Indian Medicinal Plants and Nadkarni—Indian Materia Medica. Although the drug is a very popular remedy for rheumatism, inflammation fever and a variety of other diseases, we find that practically no work has been done on its chemical constituents. There are two closely allied species of the plant one is called *Vitex negundo* and the other *Vitex trifolia* and we find that the vernacular names (Nishinda Nirgundi – Mewri— Panika Sambhalu etc.) are applied to both these species. At present we are working on the species *Vitex negundo* which can be differentiated from the species *V. trifolia* by its compound leaves—3 to 5 foliate stalked, the leaflets being lanceolate, acute, entire or rarely crenate, while in the other species the leaves are trifoliate or simple, the leaflets being sessile, obtuse and always entire. The flowers and fruits of the latter species are also slightly larger.

Ayurvedic literature recommends the use of the leaves, bark, roots and seeds of the plant. We have isolated in our laboratory from the leaves an essential oil with the following characteristics: Colour—pale greenish yellow, Odour very characteristics, Refractive index 1·475 (23°), Specific gravity with reference to water at 23°—0·9215, Optical rotation in a 10 per cent solution in chloroform—nil. The oil when applied to the tongue has some cooling effect.

From the air dried leaves of the plant we have been able to isolate an alkaloid which has been crystallised in the form of its tartarate (M.P. 238°C. Charring 242°C.).

Further work on the constitution of the oil as well as on other constituents of this plant is going on in our laboratory and will be published elsewhere.

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G. B. Singh

Department of Pharmaceutics,
Benares Hindu University,
Benares, 16-2-1944.

A NEW BALANCED INCOMPLETE BLOCK DESIGN

If v objects are arranged in b sets of k objects each such that every object occurs in just r sets; and every pair of objects occurs in just λ sets; then we get a 'Balanced Incomplete Block Design'. Such designs are important for agricultural field experiments and in other biological researches where statistical methods are applicable. The parameters v, b, r, k, λ are subject to the relations

$$bk = vr\ ;\ \lambda(v-1) = r(k-1)$$

and as shown by Fisher $b \geq v$. Only designs for which $r > 10$ are of interest. Integral values of the parameters consistent with the above were given in the first edition of Fisher and Yates tables,[1] together with the known combinatorial solutions. A number of solutions for previously unknown cases were added later by R. C. Bose[2] and others. These researches have enabled Fisher and Yates to fill in, in the second edition some of the blanks which were left in the previous one. A number of solutions however still remain unknown. I give here the solution for the case $v=16$, $b=24$, $r=9$, $k=9$, $\lambda=3$ which has hitherto remained unsolved.

(1, 2, 7, 8, 14, 15),	(1, 4, 7, 8, 11, 16)
(3, 5, 7, 8, 11, 13),	(2, 4, 8, 10, 12, 14)
(2, 3, 8, 9, 13, 16),	(5, 6, 8, 10, 15, 16)
(3, 5, 8, 9, 12, 14),	(1, 6, 8, 10, 12, 13)
(1, 6, 7, 9, 12, 13),	(1, 2, 3, 11, 12, 15)
(2, 5, 7, 10, 13, 15),	(2, 6, 7, 9, 14, 16)
(3, 4, 7, 10, 12, 16),	(1, 4, 5, 13, 14, 16)
(3, 4, 6, 13, 14, 15),	(2, 5, 6, 11, 12, 16)
(4, 5, 7, 9, 12, 15),	(1, 3, 9, 10, 15, 16)
(2, 4, 9, 10, 11, 13),	(4, 6, 8, 9, 11, 15)
(3, 6, 7, 10, 11, 14),	(1, 5, 9, 10, 11, 14)
(1, 2, 3, 4, 5, 6),	(11, 12, 13, 14, 15, 16)

As pointed out by Mr H. K. Nandi of Statistical Laboratory, Calcutta, this solution has a special interest because from it cannot be obtained by adjunction the solution of the corresponding symmetrical design $v=b=25$, $r=k=9$, $\lambda=3$; as the two blocks (1, 6, 8, 10, 12, 13) and (1, 6, 7, 9, 12, 13) have four treatments in common. So far as I know this is the first example of this kind. Details of the method by which the solution was obtained will appear elsewhere.

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Statistical Laboratory,
Presidency College,
Calcutta, 1-3-1944.

[1] R. A. Fisher, and F. Yates, Statistical tables for Biological Agricultural and Medical Research, First edition (1938), Second edition (1943).

[2] R. C. Bose, On the construction of Balanced Incomplete Block Designs, *Annals of Eugenics*, 9, 353-399, 1939.

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FAMINES, ROYAL COMMISSIONS AND COMMERCIAL COMMISSIONS

THE Central Legislative Assembly and the Council of State have discussed over several sittings the recent famine situation of Bengal, and after all, the powers that be decided to send down a Commission of Enquiry which is expected to be embellished with certain insignia of Royalty or something near regal to it. Post-mortems have always to be performed on every individual dead of causes other than natural. The near million that according to official estimates died in Bengal last year of starvation and the other millions which probably escaped official notice cannot obviously escape this ritual. And perhaps as a mausoleum, a gilded report will crown the ashes of the mass cremation. The poet has sung the doleful dirge:

> "Can storied urn or animated bust
> Back to its mansion call the fleeting breath?
> Can Honour's voice provoke the silent dust,
> Or Flatt'ry soothe the dull cold ear of Death?"

The words were indeed pregnant with prophecy. Many a Royal Commission have skipped over the country during racing seasons and gone back to send us an arm-chair or fireside message.

The Famine Commission of 1880 set up after the terrible famines in Orissa (1872), and the South India Famine (1877-1878) to find some practicable means of avoiding famines or at least of mitigating their worst effects was the first body to study seriously the possible methods of improvement. Definite action began a few years later: in 1880 Dr Voelcker was invited to India to advise on the steps to be taken; in 1892 Mr James Mollison was appointed as technical Deputy Director for the Bombay Presidency; Dr J. W. Leather came out as agricultural chemist to the Government of India, for the improvement of agriculture was then regarded as a matter more of chemistry than for any other science; sugar cane diseases were causing much loss to the cultivators in Madras and in 1898 Dr Barber was brought from the West Indies. Yet the last century ending with 1900 saw no less than 31 famines which carried away 32 million souls (roughly as much as the entire population of Great Britain) to be followed only by another Famine Commission in 1901.

We shall now examine the findings of these august bodies and their wise recommendations. The general conclusions may be stated in their own terms.

> "In good years he (the Indian peasant) has nothing to hope for except a bare subsistence: in bad years he falls back on public charity." (*Report of the Famine Commission*, 1901).

> "It is not surprising to find that the history of the Indian Agriculture in the last 100 years is the history of progressive and continuous deterioration of the soil." (*Report on the Improvement of Indian Agriculture*, by Dr. J. A. Voelcker, 1892).

And what remedies!!

> "The numbers who have no other employment than agriculture are in large parts of the country greatly in excess of those required for a thorough cultivation of the land." (*Report of the Famine Commission*, 1880).*

So get rid of them!!

> "We attach the highest importance to the establishment of some organisation or method whereby cultivators may obtain advances necessary for carrying on their business without paying usurious rates of interest." (*Report of the Famine Commission*, 1901).

Gold, silver and inflated paper is a substitute for rice and dhal!!

* The Famine Commission of 1880 clearly recognised that to prevent recurrence of famines, not only was agriculture to be improved, but industries were also to be encouraged. We quote from the report:—

(1) In treating of the improvement of agriculture........ the more scientific methods of Europe may be brought into practical operation in India by the help of specially trained experts, and the same general system may be applied with success both to the actual operations of agriculture and to the preparation of the market of the raw agricultural staples of the country. There does not appear any reason why action of this sort should stop at agricultural

"No remedies are possible except through the spread of education, the gradual growth of provident and self-supporting qualities under the influence of painful expedience and the success of the stronger and thriftier individuals in the struggle for life." (*Report of the Famine Commission*, 1880).

A good moral lecture to empty stomachs, but probably through oversight it was not mentioned that loyalty perhaps will fill in the other deficiencies in the attempts to reach the goal!

But our saintly poet Kavir has given a better solution on the same tune:

"A hungry man cannot perform Thy service,
Take back this rosary of Thine.
I only ask for the dust of the Saint's feet,
Let me not be in debt.
I beg for two seers of flour,
A quarter of seer of butter and salt.
I beg for half a seer of pulse (dal),
Which will feed me twice a day.
I have never been covetous
I only love Thy name."

Or perhaps the real solution lies in chanting the Biblical prayer thrice a day:

"Oh Lord! Give unto us this day our daily bread."

Then came the Royal Commission on Agriculture in India in 1926, which promised to inaugurate a new era in the life of the Indian countryside.

Indeed the eleven ponderous volumes of report were meant to pave the way for the enthronement of the farmer in the regal palace of the citadel of India and the grazing of our fair fields and pastures by certain John Bull's bulls. It founded an Imperial Council of Agricultural Research and "One of the conditions laid down was that the Council's activities should periodically be reviewed by some disinterested experts." The honour of being the first to do this fell on the large shoulders of Sir John Russel, Director of the famous Rothamsted Experimental Station and Dr N. C. Wright.

In the first year of tenure of the farmer Viceroy, Sir John Russel spent a pleasant winter in India and gave us the message of hope. And here it is:

"The Council's investigations should be directed to increasing the output per acre of food crops with a view both of ensuring full supplies and of liberating land for the growth of the supplementary crops and of fodder crops for the production of milk."

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produce and should not be extended to the manufactures which India now produces on a small scale or in a crude form, and which with some improvement might be expected to find enlarged sales, or could take the place of similar articles now imported from foreign countries.

(2) The Government might further often afford valuable and legitimate assistance to private persons desiring to embark in a new local industry, or to develop or improve one already existing, by obtaining needful information from other countries or skilled workmen or supervision and at the outset supplying such aid at the public cost.

"This increased productiveness is the main problem to which all others should be subordinated."

"More systematic schemes of manurial trials are necessary in order to test the relative values of nitrogen in artificial fertilizers, farm yard manures and composts."

"Green manuring should be more systematically studied."

"A Report on the manurial trials fostered by the Council should be drawn up by the statistician, with recommendations for a more systematic treatment."

But compare this halting reference to the efficacy of nitrogen fertilizers in India with his utterance in his book *'Soil Conditions and Plant Growth'* (1932) considered a Bible among the soil scientists.

"Farmers were slow to believe that 'chemical manures' could ever do more than stimulate the crop, and declared they must ultimately exhaust the ground. The Rothamsted plots falsified this prediction; manured year after year with the same substances and sown always with the same crops, they even now after ninety years of chemical manuring continue to produce good crops."

In his latest speech before the Food Group published in "Chemistry and Industry" June 5, 1943, we read:

"It seems strange that in this 20th century there should still be people who think that ammonia derived from organic matter differs in some subtle way from ammonia derived from gas liquor or produced synthetically. I know of no evidence that organic manures produce healthier or more nutritive crops than inorganic fertilizers."

And his prayer during "Britain's War time Food Production Drive" (1940).

Thanks to our highly efficient chemical industry we have almost unlimited supplies of sulphate of ammonia, and to that extent we are much better off than in the last war when nitrogenous fertilizers were very scarce."

And his last will and testament to India:

"The improvement of Indian agriculture has been attempted by many Governments over a long period of years and by a variety of methods. In the first instance Western methods were introduced on the assumption that as they had succeeded in the countries of their origin they would also succeed in India. Notable examples were the bringing in of twelve American cotton planters by the East India Company in 1839 to show how cotton should be grown, and the importation of steam ploughs and a battery of implements by the Madras Government in 1864 to show how the soil should be cultivated. In general these methods failed. Next followed a period of searching for some general policy or system of organisation; little was actually accomplished, but there was much discussion which no doubt paved the way for future action. Finally it was recognised that Indian agriculture constituted a problem of its own; it could not be modelled on any other system but must be developed to accord with the natural conditions of the country and the requirements of the people. The best hope for improvement lay in the scientific study of these conditions and in experiments to discover agricultural practices that would best suit them."

The truths of science apparently differ at different geographical centres, a thing least expected from a scientist of the order of Sir John Russel, F.R.S.

But perhaps we had no right to expect any return courtesies from our Royal guests. We have had a highly efficient Imperial Service of Agricultural experts brought from the British Isles with a pay not much below that of the reputed heaven-born service ; yet so far no scientific approach to the urgent problem of increasing the food production had ever come from that quarter.* While even in the twentieth century India is visited with famine from year to year in some part or other, out in the West, scientists developed methods of nitrogen fixation from the turn of the century. This was heralded by the prophecy of an eminent scientist, Sir William Crookes in 1898. Europe and America built factories to increase the output of fixed nitrogen compounds which have come to be recognised as the indispensable factor in the maintenance of soil fertility by agricultural scientists: De Saussure, Bousingault, Lawes and Gilbert as early as 1840. Then came the remarkable achievement of Haber, which is mentioned in every elementary book on chemistry, as having solved once for all the soil fertility question.

A recent American Chemical Society monograph on "fixed nitrogen" published in 1932 has the following passage :

> "At the beginning of the present century there existed a "Nitrogen problem". The agricultural and industrial demands for nitrogen compounds were increasing rapidly, and the natural sources of supply were limited. Today, the "Nitrogen problem", if there be one, is to find a market for the output of fixed nitrogen potentially available."

At about that time well over 2 million tons of fixed nitrogen were available to the agriculturist as a fertiliser.

In the face of these facts one fails to understand why there had been no advocacy for the use of these chemical fertilisers from any of the agricultural experts in our country.

There was always the oft-repeated statement that it is not available for India and importation is too uneconomical. When questioned as to why it could not be manufactured in India the agricultural expert would either quote the economist who could explain rationally the absurdity of that procedure or would quote the equally reactionary statistical pandit who found no statistically significant superiority of synthetic fertilizers over natural manures. Then why waste good public money on such questionable schemes: or lastly by the mere empty statement "*Technically it is impossible in India*". One also fails to see why the so-called experts were not dispensed with for indolence and inefficiency. The patient tax-payer and the victims of famines expect their servants to do what experts and public servants in other countries have done. If only the normal efficiency would have been demanded of the so-called experts, the problem would have been solved long ago. We would have then less of the disgusting attitude "*It cannot be done in India*" so assiduously taken up by the Brown bureaucrats now replacing the Whites.

It is indeed a pity that such an attitude is considered one of realism more desirable than to pretend that it can be done, out of national self-respect.

This has endowed the entire scientific and technical activity of the country with a lethargy akin to the outcome of opium addiction. However the Indian Scientific World is not without its silver lining. People are not wanting, who believe with Sylvanus Thompson

"*What one fool can, another fool too can*".

The bulk and excellence of research in the field of science by Indians to which tribute has recently been paid by no less an observer than the Secretary of the Royal Society is a sufficient guarantee that Indian Scientists can undertake what Haber did 30 years ago. They have not hesitated to proclaim the radical solution to the problem.

Dr A. C. Ukil of the All-India Institute of Hygiene and Public Health, Calcutta, suggested the advisability of synthetic fertiliser as early as 1939 in a meeting of the Food and Nutrition Exposition at Calcutta and at a symposium before the Indian Science Congress, 1941.

In 1943, its need was emphasized by members of the Food Production Advisory Committee, Government of Bengal in its various meetings.

Dr H. K. Sen, Director, Lac Research Institute, in a lecture delivered before the Indian Chemical Society in July, 1943, asserted :

> "If the State moves expeditiously, the bringing into existence of fixed N_2 industry is a question of half a year only."

Under the darkening clouds of famine over Bengal, the Food Grains Policy Committee in November, 1943, advocated the immediate importation of plants for the manufacture of synthetic fertiliser as the incredible Bolsheviks have done in Russia and stamped out recurrent famines in Russia in a ludicrously short time. The report even asserted that this was the only solution for increasing the yield of rice quickly.

In pursuance of the Resolution of the Nutrition Committee, Sanitary Board, Government of Bengal, a technical sub-committee proposed in a Food Technology Report the fabrication locally of a pilot plant for the manufacture of synthetic ammonia. The

* According to well-informed sceptics, the recent 'grow more food campaign' has resolved itself into a 'grow more officer campaign'.

technical sub-committee of the Food Production Advisory Committee, appointed in September, 1943, studied the whole question and in their final report in March, 1944 discussed the present knowledge providing considerable details. They even proposed to do fundamental research on nitrogen fixation with the help of the pilot plant to be fabricated. We understand that blue prints are being drawn for a plant of 100,000 tons of ammonium sulphate per annum according to the latest American modifications of the original Haber-Bosch process.* The radical solution of the famine problem, and of permanent malnutrition problem lies in pushing energetically with these schemes.

Meanwhile we hear a technical commission from England is arriving to advise us on the development of the Fertiliser Industry. It has become a fashion in these days to import experts on all and sundry affairs for short commissions in contrast to the permanent commissions of the past. The most recent consisted of experts on Dehydration. We fail to see why the Indian tax-payer's money is being wasted on such so-called experts from countries which have made the least contribution to the subjects concerned. Dehydration industry in America is something beyond the capacity or dreams of Britain. How could these dehydration experts have been of any help to the development of the Indian Industry on modern lines? Nitrogen fixation industry is another which has developed to a high pitch largely due to the Federal Department of Agriculture in the fixed Nitrogen Research Laboratory, in Washington, D. C. There are a large number of plants built in America with the designs of this laboratory and there is a considerable body of research workers on the subject with international reputation. England, on the other hand, possesses just one synthetic ammonia plant and that built over 26 years ago. No mention is made in the literature of any design or improvement of British origin for the necessity for getting nitrogen out of the air does not arise in England, and the problem never engaged the serious attention of British scientists.†

We cannot but wonder at the technical competence and wisdom of the people in power responsible for selecting this commission. There appears to be something rather sinister in this move. The members of this commission are said to be employees of a firm of chemical manufacturers. If that is so it is a case of prosecution, defence, jury, judge and executioner all in one body. The game is obviously set for conveniently carving out a liberal helping of our Sterling Balances in London.

What can a Nitrogen Fixation Commission do in India? Are they to try and find out if nitrogen would care to combine with hydrogen under the climatic, economic and political conditions prevailing in India? Have we not learnt enough of the bitter lessons from such experts in the past? *The best thing for us would have been to send a commission composed of purely Indian scientists and Indian financiers to tour America, Russia and England (if necessary) and see for ourselves what is suitable for us and our pocket.* A competent body of scientists capable of dealing with such a problem, and a body of financiers capable of financing such plants exist in the country, provided import facilities of the necessary machinery are given.

The decision to call foreign experts is therefore not only superfluous, but opposed to the country's interest. As a marked contrast to all these manouvres high praise is due to the wise statemenship of the Indian State of Mysore, which imported an American plant, got it installed with the aid of American experts and is according to our information successfully running it with native Mysorians. The best that could happen to such a Commission coming to India is that they are likely to see for the first time in Mysore a plant which will give them some education, and the Indian taxpayer is to pay for the foreign experts' education and be told that they have been educated. Such episodes enacted by the Central Government can only help to widen the breach between the Suzerain and the peripheral authorities. It is said that the various Provincial Governments and the States are likely to participate in the discussions. We hope the Provincial Governments will not walk into the trap so naively laid. Let the provinces go to Mysore, learn what miracles can be effected by development of electric power resources all due to the enterprise of Indian Dewans and see for themselves the capabilities of indigenous skill. Let us get our youngsters trained in a factory built in India* to suit Indian conditions.

* It is reported that the famous Du Pont de Nemours, Chemical Manufacturers of U. S. A., spent nearly a million dollars in research alone for working out the methods for manufacture of synthetic ammonia according to the Haber-Bosch process. As a result of these works, the methods of manufacture are standardised as in the case of sugar manufacture, and standard plants with experts can be had from the U. S. A. They can be set up wherever cheap electricity is available.

† England gets most of her nitrogen from ammonium sulphate which is obtained as a bye-product in coal-distillation. Her needs for synthetic nitrogen is not therefore so great as in other countries, and she has not paid as much attention to the installation of synthetic ammonia.

* This kind of work, *viz.*, training young chemists in the use of a pilot plant for the manufacture of synthetic ammonia can best be done in a National Chemical Laboratory. But this institution, advertized now for three years by the authorities of the Board of Industrial and Scientific Research, has not yet passed the report stage, and we understand that the Board has after three years of committee meeting discovered that it required a whole-time chemist to plan the laboratories!

NEED AND POSSIBILITIES FOR THE PRODUCTION OF SYNTHETIC FERTILIZERS

"ARGON"

IN 1898 Sir William Crookes, the famous British scientist who rose to be President of the Royal Society, in the course of his presidential address to the British Association for the Advancement of Science drew attention to the fact that the world was facing ultimate starvation, because under the existing conditions of heedless culture, the cereal growing lands were rapidly becoming exhausted of nitrogen. Crookes said:

> "England and all civilized nations stand in deadly peril of not having enough to eat. It is the chemist who must come to the rescue of the threatened community. It is through the laboratory that the starvation may ultimately be turned into plenty."

What were the facts which led the famous scientist to make this pessimistic prophecy?

The facts are that plants require nitrogen for building up their bodies, and this they extract mostly from the soil. A part of this loss is compensated for by farm manures, decayed remains of plants, and from air, but there is on the whole an adverse balance as was found by Boussingault as early as 1841 (Table 1). On the whole, regions of the world which have supported civilized communities for a long time —and therefore the oldest centres of civilization— show a great deficiency of nitrogen content in their soil, which in these regions therefore yields less and less, and ultimately the regions tend to become sterile, and cannot support the population. This probably happened in Mesopotamia which, at the time of Herodotus, yielded 200 times the amount of seed put in the soil, but in course of the last few centuries had become mostly a barren desert. This has also happened to soil in the river valleys of India, one of the oldest inhabited regions of the world, and was happening to European soil according to Crookes.

How could the situation be met? The answer was plain and simple: by putting back the nitrogen in the form of artificial fertilizers and farm manures. The manures are limited in quantity, hence artificial fertilizers must be used. We shall now do well to refer to the possible sources from which the supply of artificial fertilizers may be available.

Potassium Nitrate or Saltpeter is found in large quantities in India, but it was exported till the middle of the last century mostly for the manufacture of gun-powder.

Sodium Nitrate or Chili Saltpeter is found in inexhaustible quantities in Chile, South America. The export of Chili Saltpeter started from 1830, and gradually killed the export trade of Indian Saltpeter. It has been used since 1850 as a manure in Europe to replenish the nitrogen in agricultural soil. In 1912, as much as half a million tons were exported. The export of Chili Saltpeter formed the chief source of income of the Republic of Chile in South America.

TABLE 1

NITROGEN STATISTICS OF VARIOUS ROTATIONS BOUSSINGAULT (1841)

Rotations.	*Nitrogen in manure*	*Nitrogen in crop*	*Excess in crop over that supplied in manure per rotation (kilograms per hectare)*
(1) Potatoes (2) Wheat (3) Clover (4) Wheat turnips (5) Oats	203·2	250·7	47·5
(1) Beets (2) Wheat (3) Clover (4) Wheat turnips (5) Oats	203·2	254·2	51·2
(1) Potatoes (2) Wheat (3) Clover (4) Wheat turnips (5) Peas (6) Rye	243·8	253·6	109·8
Jerusalem Artichokes 2 years.	188·2	274·2	86·0
(1) Dunged fallow (2) Wheat (3) Wheat	82·8	87·4	4·6
Lucerne 5 years	224·0	1087·0	854·0

Ammonium Sulphate which is obtained as a bye-product in the distillation of coal is also a valuable source of nitrogen, and in 1912 277,000 tons were produced.

But these quantities were limited, and the sources were showing signs of exhaustion. The way

out was pointed out by Crookes. In the same address, he said:

"The fixation of atmospheric N_2 is one of the greatest discoveries awaiting the ingenuity of the chemists. It is certainly deeply important in its practical bearings in the future welfare and happiness of the civilized races of mankind."

Nitrogen forms 80 per cent of the atmospheric air, and the source is apparently inexhaustible.

Fixation of Nitrogen: Calcium Nitrate, Calcium Cyanamide, Synthetic Ammonia

Priestly observed over 150 years ago that nitrogen and oxygen of air could be made to combine to form oxides of nitrogen which dissolved in an alkali could give us nitrates and nitrites. Its commercial development was made possible only after considerable progress was made in the generation of cheap electrical energy. In 1902, a plant employing this finding was set up near Niagara Falls where cheap power from hydroelectric sources was available. In 1904, two Norwegian scientists, Birkeland and Eyde, built their famous arc method of nitrogen fixation by which nitric acid could be obtained from air, which by neutralization with lime, provided a valuable nitrogenous fertlizer, nitrate of lime, which is very good for acid soils. About the same time the discovery was made that calcium carbide could be made to combine with nitrogen to give calcium cyanamide. This substance could be applied directly to the soil as a nitrogenous fertiliser or the cyanamide could be hydrolyzed with water to give ammonia. But these quantities were limited.

During the first World War the Allies hoped that Germany would have to surrender, as blockade was effective in completely preventing the importation of Chilian nitrate fertilizer and thus cause a collapse of the food front.* The Germans however stood out for over four years and this was ascribed to the German's successful method of fixing nitrogen in a novel and effective way. Fritz Haber, the German chemist succeeded sometime before the war in combining directly nitrogen and hydrogen at high pressures and temperature into NH_3 with the help of certain suitable catalysts. This started as an obscure laboratory experiment and guidance was obtained from mathematical formulae evolved in physical chemistry. But the German industrialists and the State were quick to realize its potentialities. The famous Badische Anilin and Soda Fabrik put all their resources at the disposal of Haber, and after years of effort, just before the outbreak of the first World War of 1914, an industrial plant for producing 7000 tons was put in operation (The Haber-Bosch process). But by the time the armistice came, Germany was fixing 137,000 tons of NH_3 by this method. Whatever might have been the technical difficulties and the financial implications an achievement of this nature in such a short time opened the eyes of the European nations. Almost all European and North American countries seized on the idea and built up large manufacturing plants and in less than 20 years, a total of 2 million tons of synthetic ammonia was being manufactured per annum. Well over 92 per cent of this fixed nitrogen went into the soil as a fertilizer. That in brief is the romantic tale of the way in which the European countries succeeded in maintaining soil fertility.

* The Chilian nitrate is used not only as a fertiliser, but also as a source of explosives used for the prosecution of the war.—Ed. *Sci. & Cul.*

Synthetic Ammonia solves Germany's Food Problems during current War

In a recent issue (March 3, 1944), *Science* has published a note on the present food supplies in Germany. Dr J. T. Richter, of the Office of Foreign Agricultural Relations, U. S. Department of Agriculture, stated in the official publication, Foreign Agriculture, that, in his opinion, Germany's production and consumption of food thus far in this war have been at a level far above those for 1914-1918.

"In contrast to the situation in 1914, Germany's food economy in 1939 was well prepared for war. Following a period of sustained expansion, agricultural production has reached a high level. Over 85 per cent. of the nation's food supply was produced from domestic resources, the only substantial deficit being in fats and oils. From 1937 until the outbreak of war, stocks of grain, fats and sugar had been accumulated in considerable quantities." In the years just prior to World War I, German livestock was dependent upon the importation of feed to the extent of about 38 per cent. of the total output of livestock products. In 1939 the dependence on imported feeds was not more than 10 per cent., with the result that livestock production has been considerably less affected in the past four years than during the 1914-1918 period.

"An important factor in the high level of farm production was the relatively large supply, up to 1943, of commercial fertilizers other than phosphates. Especially important was the availability of nitrogen in quantities six or seven times as great as in the previous war. "This excess even after allowance has been made for the drastic reduction in phosphates, may still be estimated as accounting for an annual crop production of over 6,000,000 tons in terms of grain."

In the opinion of Dr Richter, Germany's own production has remained the backbone of its wartime food supply, despite the importation of substantial quantities requisitioned in other parts of continental Europe under German control.

Progress made in the various countries of the world in the production of synthetic ammonia, nitrogen compounds and in the use of fertilizers for

agriculture has been adequately reflected in the following tables:—

TABLE 2

SYNTHETIC AMMONIA PLANTS OF THE WORLD, 1930

(Annual Capacity in Net Tons of Nitrogen)

Country	Direct synthetic		Cyanamide		Total
	Number	Amount	Number	Amount	
Germany ..	9	766,100	5	102,200	868,300
France ..	20	172,300	5	32,100	204,400
U. S. A. ..	8	143,800	1	35,700	179,500
Japan ..	6	98,700	4	56,800	155,500
England ..	1	151,800	nil	nil	151,800
Belgium ..	6	118,700	nil	nil	118,700
Norway ..	2	76,900	1	13,400	90,300
Netherlands ..	3	80,400	nil	nil	80,400
China (1935) ..	1	75,000	nil	nil	75,000
Poland ..	4	47,300	1	26,800	74,100
Canada ..	1	2,200	1	71,400	73,600
Italy ..	9	43,300	5	19,600	62,900
Russia ..	2	35,700	nil	nil	35,700
Yugoslavia ..	1	14,300	2	12,500	26,800
Czechoslovakia ..	2	11,900	1	5,400	17,300
Switzerland ..	1	6,700	3	4,500	11,200
Spain ..	3	7,700	nil	nil	7,700
Sweden ..	1	1,800	2	5,400	7,200
Roumania ..	nil	nil	1	5,000	5,000
Indian States Mysore (1941) ..	1	1,500	nil	nil	1,500
British India (1941)	nil	nil	nil	nil	nil

TABLE 3

GROWTH OF WORLD PRODUCTION OF NITROGEN COMPOUNDS

(In Net Tons of Nitrogen Per Year)

Year	By Synthetic Fixation Methods	By Bye-product and others	Total
Early 1913 ..	nil	67,200	67,200
September 1913.	7,000	67,200	74,200
1914 to 1918 ..	137,000	72,000	209,000
1924	378,700	659,400	1,038,100
1925	428,300	705,400	1,133,700
1926	548,200	671,700	1,309,900
1927	602,400	639,500	1,241,900
1928	792,600	900,600	1,693,200
1929	1,041,100	1,034,200	2,075,300
1933	1,171,400	479,400	1,650,800
1934	1,226,500	537,500	1,764,000
1935	1,350,600	687,100	2,037,700
1936	1,597,600	758,000	2,355,000
1937	1,801,400	853,500.	2,654,900
1938	1,969,700	865,300	2,835,000
1943			
British India..	nil	5,200	5,200
Indian States Mysore ..	1,500	nil	1,500

Note: Well over 92% of the production is consumed as fertilizer.

Total World Population ... 2,222 millions
Mysore .. ... 7 ,,

British Indian population is nearly 1/5th of world population but produce only 1/560th of world nitrogen.

TABLE 4

FERTILIZERS USED IN AGRICULTURE CONSUMPTION IN INDIA AND SOME EASTERN COUNTRIES.*

In 1000 metric tons†

	Average for 1928-32	1933	1934	1935	1936	1937	1938
1. Superphosphates for Lime:							
(*a*) Net consumption							
India	3·4	2·5	5·1	5·0	6·4	7·9	8·1
Japan	896·6	1009·7	1004·6	1151·0	1242·4	...	...
(*b*) Home production							
Japan	946·9	1116·6	1126·1	1331·6	1437·2	...	...
2. Potash fertilisers:							
(*a*) Net consumption							
India	6·7	3·0	7·0	5·7	3·8	3·9	4·4
Japan	33·4	30·8	50·2	84·1	81·5	...	...
3. Nitrate of Soda:							
(*a*) Net consumption							
India	5·7	2·0	3·8	2·2	2·6	3·1	2·7
Japan	25·9	19·7	23·4	36·9	47·6	..	...
4. Sulphate of Ammonia:							
(*a*) Net consumption							
India	34·6	41·8	48·2	54·9	74·1	65·5	87·2
China	124·4	101·3	49·9	68·6	124·0	163·4	106·4
Japan	540·0	551·3	650·4	812·6	1050·4	...	...
Korea	105·0	183·6	213·0	273·9	306·6	327·9	...
Neth. Ind.	112·0	29·4	43·6	41·1	69·2	102·5	70·5
Formosa	61·	72·1	111·8	117·6	147·6	148·5	...
Philippines	28·8	38·9	58·2	34·4	47·0	35·9	29·7
(*b*) Home production							
India	14·4	9·8	13·2	17·7	18·0	18·6	14·8
Japan	317·2	471·4	494·3	611·8	880·3	...	...
Manchukuo	18·0	30·0	30·0	200·0	250·0	...	...
Korea	111·9	247·0	310·4	350·4	396·8	422·3	...

* From "Land and its Problems" by Sudhir Sen.

† (One metric ton=2000 lbs.)

FERTILIZERS USED IN AGRICULTURE—CONSUMPTION IN INDIA AND SOME EASTERN COUNTRIES—*Contd.*

In 1000 metric tons

	Average for 1928-32	1933	1934	1935	1936	1937	1938
5. Calcium Cyanamide:							
(*a*) Net consumption							
India	Nil	Nil	Nil	Nil	Nil	...	...
Japan	91·5	140·8	104·8	155·6	160·5	...	...
(*b*) Home production							
Japan	91·7	151·4	138·5	199·7	219·4	...	
6. Bones and Bone Manures:							
Net exports from India (by Sea)	−60·5	42·5	-52·6	67·2	-88·8	−110·1	−56·2[2]
-- ditto-	34·4	−18·1	−26·5	−29·9	30·8	−38·9	−21·9[3]
Net imports into Japan ..	+27·0	+22·3	+24·6	+25·8	+26·7	+22·1	+12·4[2]
—ditto—	+35·1	+24·1	+28·6	+29·7	+35·5	+29·5	+21·9[3]

SOIL FERTILITY AND NITROGEN

What has been the effect of all these great scientific work? Europe and the countries which have harnessed science to their needs have maintained the fertility of their soil, whereas countries which have neglected science are getting barren as the following table shows: —

TABLE 5

YIELD OF RICE IN LBS. PER ACRE IN DIFFERENT COUNTRIES

(*Report of the Paddy and Rice Enquiry Committee, Vol. 1, Government of Bengal, 1935*)

Bulgaria	1,904	Korea ...	1,759
Egypt	3,179	Siam ...	1,398
Formosa	2,220	Spain ...	5,542
Indo-China ...	1,032	U. S. A. ...	2,138
Japan	2,988	India ...	828
Java	1,322	Bengal	884
Italy	4,748		

The above table was prepared from figures of yield available in 1935, after which an authoritative statement made in December, 1943 would appear to give the figure of rice production as 738 lbs. per acre which is an average of the production record of the previous 5 years.

The table speaks its own tale. Countries like Spain, Italy and Japan, and Egypt which use fertilizers extract seven to four times as much crop from their soil as we do in India. Even countries like Korea and Formosa which suffer from "*Japanese Brutality*" get two to two and halftimes as much as India which enjoys the advantage of "*Enlightened British Imperialism*"! Further comment is unnecessary! What has been said of rice can be said of almost every other crop and the sequel is too tragic to describe.

RECURRENT FAMINES DUE TO LOSS OF SOIL FERTILITY

"In an enquiry into certain public health aspects of village life in India by the Director General, India Medical Service published in 1933, it was estimated that in 40 per cent of the villages in all India the population was excessive in relation to food supply. According to the same enquiry periods of scarcity of food occur in one village out of every five during a ten year period in which there was no exceptional failure of rain. When the rain fails scarcity gives place to famine; during the last quarter of the nineteenth century there were 18 severe famines which caused 26 million deaths" thus reads a passage in a book "Food and Planning" by J. R. Marrack published in London in 1943. The twentieth century has not shown any improvement over the previous century. Famines of moderate dimensions have occurred from year to year, and the following table gives a rough idea of the expenditure incurred by the Government of India during the period of only 12 years in the last two decades.

TABLE 6

Years.	*Rupees.*	*Years.*	*Rupees.*
1924-25 ...	23,28,535	1931-32 ...	16,39,301
1925-26 ...	14,10,429	1932-33 ...	8,02,936
1926-27 . .	15,49,723	1933-34 . .	3,48,793
1927-28 ...	19,17,890	1934-35 ...	10,20,816
1928-29 ...	23,18,740	1936-37 ...	15,10,136
1929-30 ...	48,93,056	1935-36 ...	19,56,331
1930-31 ..	20,02,060		

It is not necessary to refer to the unprecedented famine that swept over unfortunate Bengal. Several millions were victims of starvation and its after effects. The loss sustained by the State in terms of money would probably be not less than 100 crores of Rupees.

All this loss of human material and wealth was entirely preventable if only a fraction of all this cost had been utilised in increasing the productivity of the land. This would appear at first sight to be exceedingly possible. It is evident from table 5 that if only we could produce as much as some of the less progressive countries of the world such as Bulgaria and Korea, we should have been able to have twice the amount of food that is now being produced.

Elmhirst wrote in the *Modern Review* of October, 1922 as follows: "To continue indefinitely taking any of these life forming elements from the soil without adequately replacing them is a robbery not merely of the soil itself but also the future generation which will have to live on it. Thus the damage done to the district of Birbhum and other large parts of India to-day is irreparable."

We are caught in a vicious circle of increasing population and decreasing soil fertility.

Prospects of Fertilizer Industry

To get out of the circle we require large scale fertilizer industries, not only for the manufacture of nitrogen fertilizers, but also for the manufacture of phosphate, potassium and other fertilizers. India possesses all the raw materials needed for the purpose. She requires will power on the part of her rulers, and leaders of Industry to bring these industries into existence. Let us first examine our requirements.

Dr H. K. Sen estimates that a minimum of only 100 million acres of land being suitable for manuring would require on the basis of 20 lbs. of nitrogen per acre, 1 million tons of nitrogen, leaving aside other acres under cultivation of sugar-cane, tea, cotton, etc. which would have their own share.

An authoritative estimate stated in December, 1943 that the requirement is 2·8 million tons of nitrogen.

However we can calculate on a slightly different basis. The amount of food crops acreage of British India is 215 million acres. If at the rate of 20 lbs. nitrogen is used as manure for each acre, the quantity required is calculated to be 2·2 million tons of nitrogen. It is desirable to employ as much as 90 lbs. of nitrogen per acre. We thus have the figures of requirement ranging from 1 million tons to 8·6 million tons of nitrogen per annum.

Farm Manure and Composts no substitute for Synthetic Fertilizers

We will now determine the nitrogen available from all sources. An authoritative statement made in December, 1943 gave the availability of farm yard manure as 5·9 million tons with a nitrogen content of 0·4 per cent or 0·024 million tons. Dr N. C. Acharya estimates that with effort it is possible to obtain 10 million tons of compost with the nitrogen content of 0·4 per cent. Even this works out to only 0·04 million tons. These figures demonstrate how little of nitrogen is available from the natural sources. It is only one twentyfifth of even our lowest estimate of requirement.

The supply of indigenous oil-cake manure would also appear to be extremely inadequate. The total quantity of oil-cake produced in the country amounts to about 14½ lakh tons per annum. Half of this is required for feeding the cattle and the remaining half is insufficient for manuring the intensively-grown crops, such as sugar-cane, potatoes, vegetables, tea and so forth and hardly anything is left for manuring foodgrains, although efforts have been made to utilize part of the available supplies for manuring the foodgrains crops particularly rice.

It was mentioned at one time that India held world monopoly for Saltpeter. The Chilian Nitrate industry not only broke the monopoly but also disorganised the industry so that there is practically no production of this commodity now.

The nitrogen compounds available from coal are however important and as a matter of fact, England which is one of the largest consumers of coal, get most of her nitrogen from Ammonium Sulphate which is obtained as a bye-product in coal-tar distillation. Let us examine the case for India. It is estimated that 5,200 tons of fixed nitrogen are being produced from 4 million tons of coal used in the metallurgical industry. India is producing annually a total of 25 million tons of coal. If the whole of this would have been submitted for retorting we would get a total of 32,000 tons of nitrogen. It is stated also that the retorting is rather wasteful and by improvement we can get instead 60,000 tons of nitrogen. Still further improvements such as by the system of Mond gasification it is theoretically possible to obtain as much as 180,000 tons of nitrogen.

We thus see that even from the complete utilization of ammonia from the entire coal production of India, the amount of nitrogenous compounds available is not even 1/5 of the lowest estimate of the requirement of this commodity.

Judged from a more desirable estimate of 8·6 million tons of nitrogen required for food crops alone, our situation is exceedingly critical. This becomes much more so if we have to fertilize our other cash crops such as sugar-cane, cotton, tea and coffee.

The question is usually asked: Can the Indian farmer afford to pay for the synthetic fertilizer? This is usually answered in a pessimistic manner. The proverbially poor Indian cannot afford this luxury.

Use of Synthetic Fertilizers is Profitable

However, it can be demonstrated that synthetic fertilizers pay themselves in the form of increased yield.

The normal pre-war cost of ammonium sulphate is Rs. 80/- per ton *i.e.* 448 lbs. of nitrogen. An application of 20 lbs. of nitrogen per acre has been stated to give an extra 3 maunds of cleaned rice. That is, for less than Rs. 4/- of fertilizer, we obtain 3 maunds of rice. The normal price level for rice is Rs. 5/- per maund. In other words, we get a return of Rs. 15/- for less than Rs. 4/- manure. The lowest level of price for rice was Re. 1/8/- per maund.

Even so we get Rs. 4/8/- and straw for Rs. 4/- manure. Calculating on the present price of Rs. 15/- per maund of rice it should pay enormously. The present price of imported ammonium sulphate is well over Rs. 200/-, in which case we have to pay as much as Rs. 10/- per acre, but then if we calculate on the basis of the present price of rice, it will bring Rs. 45/- worth of excess yield. Even at Rs. 5/- it is well over the cost of fertilizers. An authoritative statement made in December, 1943 showed that in certain cases ammonium sulphate paid itself handsomely even when it cost as much as Rs. 269/- per ton and rice was sold at Re. 1/6/- per maund. These are the figures with imported material. The cost of production of one ton of ammonium sulphate by synthetic ammonia methods is only Rs. 40/- to Rs. 45/- or about half of the pre-war costs. There will then be no question whether such a manure will pay or not.

Synthetic Ammonia Plants can be erected in India

Among the methods of nitrogen fixation the most suitable one for India is the direct synthetic ammonia method according to Haber with more recent modifications developed particularly in America. The raw materials needed for this industry is available in inexhaustible quantities. According to some of the older methods, we need $CaSO_4$ or gypsum available only in certain parts of India and that perhaps in limited quantities. However, modern methods employ the limitless quantities of NaCl that can be extracted out of sea water along the entire coast line of India. In still more recent plants there are no raw materials other than what cannot be obtained from the atmosphere. There will of course be a need for a certain amount of electrical energy which is not anything very considerable. A plant costing 2½ crores of rupees could be built with an output capacity for 20,000 tons of fixed nitrogen per annum. The period of fabrication should perhaps not exceed 2 years.

It should be remembered that Haber during the first World War built one of the very first plants in less than eleven months and was capable of producing 30,000 tons of fixed nitrogen per annum. With the experience of the last 30 years we should be capable of doing something better than what Haber was capable of.

This plant is estimated to produce ammonium sulphate for the price of about 40-45 Rupees per ton which is roughly ½ the pre-war cost of Rs. 80/- and the present price is over Rs. 250/- per ton.

The State should take the lead in building such plants as the progressive Indian State Mysore has done. If however private enterprises come forward the State should do all in its power to help it. Possibilities of obtaining plants from America on lease and lend basis should be explored.

RAYON INDUSTRY IN INDIA

RAYON is the other name for artificial silk. The process of making this synthetic fibre was invented about the year 1883-84 by Count Chardonnet of France and Sir Joseph Swann of England. Since that date research in artificial silk has made such headway that rayon industry has been an established and profitable industry in Europe, America and Japan. Artificial silk in the form of yarn and staple fibre at present constitutes an increasingly important addition to natural fibres like cotton and silk as raw materials for the textile industry. In fact, its introduction has made possible such wide varieties of yarn and piece goods that textile industry has increasingly come to depend on rayon industry all over the world.

Rayon industry is as yet unknown in India. The absence of an indigenous rayon industry to meet Indian textile industry's growing demand for artificial silk has naturally led to a heavy drainage of money amounting to several crores of rupees annually from this country. The monograph on "The Rayon Industry", recently issued by the All-India Manufacturers' Organization, Bombay, in order to indicate the urgency and possibilities of setting up this industry in India, has published figures for imports of artificial silk yarn and piece goods into this country, which we may do well to reproduce here.

Imports of Artificial Silk Yarn or Rayon in India (in 1000's of lbs.)

Year		Import	Year		Import
1924-25	...	1,171	1932-33	...	11,002
1925-26	...	2,671	1933-34	...	9,808
1926-27	...	5,776	1934-35	...	16,614
1927-28	...	7,510	1935-36	...	14,911
1928-29	...	7,668	1936-37	...	17,628
1929-30	...	7,353	1937-38	...	31,589
1930-31	...	7,119	1938-39	...	17,200
1931-32	...	7,963	1939-40	...	30,794

These figures at once disclose the dependence of Indian textile industries on foreign rayon manufacturers. The tremendous rise in the imports of arti-

Imports of Rayon piece-goods in India

Year		Yards	Value (Rs.)
1934-35	...	68,489,000	1,88,02,000
1935-36	...	72,999,000	1,87,08,000
1936-37	...	99,259,000	2,32,95,000
1937-38	...	91,953,000	2,28,63,000
1938-39	...	29,616,000	1,04,36,000

ficial silk yarn from 4 lakhs of lbs. in 1923-24 to about 3 crores of lbs. in 1937-38 is simply disquieting.

If the import of piece-goods be calculated in terms of yarn, we note that India imported about 50,000,000 lbs. of rayon valued at a few crores of rupees in 1937-38. Such a heavy and undue drainage could have been prevented, if there were an indigenous rayon industry, to the immense benefit of this country.

In exploring the possibilities of setting up the rayon industry in India, the monograph has discussed India's position with regard to the supply of raw materials, chemicals, power, technical personnel, labour and such other things required for successful manufacture, to which the attention of the State and our industrialists may be drawn.

Raw Materials

The main constituent of artificial silk is cellulose. It can be obtained from wood-pulp or cotton and cotton linters. In Europe and America rayon is now largely manufactured from wood-pulp by the well-known viscose process. This is because of the easy and cheap availability of wood-pulp in Norway, Sweden, Canada and U. S. A. But high-grade artificial silk can also be economically manufactured from cotton waste by the acetate process. As India commands an abundant supply of short-staple cotton and cotton linters, cotton waste should ultimately be the source of cellulose for rayon industry in India.

Owing to the higher prices of cotton waste and cotton linters, it may be questioned whether the production of rayon from cotton will prove economic and stand competition with the foreign product utilizing wood-pulp. The following consideration indicates that utilization of cotton waste and linters should prove economic in the long run. The present cost of wood-pulp is 1 anna and 9 pies per lb. and that of chemical cotton made out of short staple cotton and cotton linters 3 annas 6 pies and 2 annas respectively. But the α- cellulose content of wood-pulp is 87 per cent, whereas that of chemical cotton is at least 98 per cent, and as such the potential value of chemical cotton is much greater than that of wood-pulp. Moreover, the quality of rayon from cotton is definitely superior to that from wood-pulp. When these facts are properly weighed production of rayon from chemical cotton would appear to be a profitable undertaking.

Besides wood-pulp and cotton waste, there are other sources of cellulose for the manufacture of rayon. Bamboo-pulp is by far the most important of them. Experiments recently conducted in America have proved that rayon can be produced from bamboo-pulp by the viscose process. Some experiments were also conducted with initial success by the Dehra Dun Forest Research Institute to develop a process of making bamboo-pulp suitable for rayon manufacture, and more investigations are needed in this direction. Bagasse is another important raw material whose suitability for the manufacture of rayon may yet be decided by further research. It is further reported that the lower ranges of the Himalayas abound in good quality spruce from which wood-pulp almost as good as the European or the American variety may be produced. In fact, there are reasons to believe that if the Forest Research Institute, Dehra Dun, concentrate their research on the utilization of Indian woods for the supply of cellulose for the manufacture of artificial silk, production of viscose rayon will also be a practical and economic proposition in India.

Chemicals

The important chemicals required for the manufacture of rayon are carbon di-sulphide, caustic soda and sulphuric acid. Carbon di-sulphide is not manufactured in India and plants have to be installed for the manufacture of this chemical. Caustic soda and sulphuric acid are, however, manufactured, but their production rate will have to be increased. The annual production of caustic soda is at present about 5,000 tons, a figure which is likely to be increased to about 15,000 tons in near future. Present production of sulphuric acid has been estimated at about 70,000 tons with possibilities of increased production in the years to come. Other chemicals required are zinc sulphate, sulphate of ammonia, sulphate of magnesia, sulphate and bi-sulphate of soda, and the mono-sulphide and sulphite of sodium, and glucose. It is true that India's normal requirements for chemicals are not met by her insufficient chemical industries. But in view of the possible expansion of her chemical industries and easy availability of imported chemicals from other countries in the post-war period, the problem of the supply of chemicals does not appear to be a serious obstacle to the establishment of this industry in this country.

Power and Water Supply

Cheap electricity is necesary for economic production of rayon. Supply of cheap electricity, however, can be guaranteed if the industry could be established in the vicinity of a hydro-electric station. If this cannot be secured the industry should be situated near a coal producing district so that it can produce its own electricity at a cheap rate.

The process of manufacture calls for an abundant supply of fresh water. Accordingly continuous supply of fresh water is another important condition for the location of the industry. This requirement necessitates the establishment of rayon factories on the banks of big perennial rivers, as the western countries have done. It should be noted in this connection that the large volume of water, after doing its job in the factory, should not be allowed to con-

taminate irrigation canals or water-supply systems, but should be discharged into the neighbouring valley or sea, as this water contains poisonous chemicals.

Technical Personnel and Labour

The problem of technical personnel and labour does not appear to present serious difficulties. The manufacture of artificial silk is more in the nature of a chemical process than of a textile process. The manufacturing technique has been so much improved in recent years that the whole operation is continuous, automatic and mechanical requiring little skill on the part of labourers. The chemist responsible for the precise regulation and supervision of the various processes should, however, be an expert hand at that. Under him will work a number of foremen and assistant chemists to supervise the work of the operatives. There is no dearth of chemists and scientists with the required technical qualifications and abilities in this country to run such manufacturing concerns, and where further and special training is deemed necessary, instead of importing foreign experts on fancy salaries, our men may be sent abroad to master that particular technique. During the installation of the plant, help and services of foreign technicians associated with the firms supplying the machinery may be easily obtained. It has been estimated that a factory turning out 4 tons of rayon daily will not require more than 750 men on a liberal calculation.

Unit of Production, Capital Outlay and Profit

The monograph has suggested that a rayon manufacturing plant to be sufficiently profitable should have an out-put capacity of about 6 to 10 tons of yarn per day. A plant with a production capacity of less than 6 tons a day can only be set up at the risk of a reasonable margin of profit. Establishment of very big rayon factories does not also appear advisable as the distribution of the product over a wider area necessarily involves heavy freight charges. A number of rayon factories with 10 tons a day as the unit of production may be established throughout the length and breadth of this country. The following estimate suggested in the monograph indicates that a capital outlay of about one crore of rupees will be required to establish such a rayon factory. The cost of production per lb. of yarn has also been roughly calculated, as shown below. Thus the cost of one lb. of yarn will amount to about 8·17 as. on a liberal estimate. Since the average selling price of first grade 150 deniers artificial silk yarn 12·5 as. per lb., in normal times a margin of nearly 4 as. per lb., *i.e.*, 50 per cent, is indicated, according to this calculation. On the basis of 300 working days per year, the annual output of a 10 ton plant will be 3,000 tons or 73,20,000 lbs. of yarn which will produce a net annual profit of more than Rs. 18 lakhs. This profit can be substantially increased if manufacture of transparent paper and staple fibre be simultaneously undertaken, along with the manufacture of rayon yarn. In fact, transparent paper or cellophane is of the same chemical composition as rayon yarn and requires the same chemical processes and almost the same machineries. The cost of a complete machine capable of producing one ton of cellophane paper daily will not exceed Rs. 500,000, including transport charges, customs duty and erection expenses. But a profit of about Rs. 5 lakhs may be derived annually, and as such the production of cellophane paper and staple fibre may be simultaneously undertaken.

Capital Investment

		Rs.
1.	Land	Free
2.	Building	500,000
3.	Pulp Making Machinery	500,000
4.	Rayon Manufacturing Machinery ...	5,000,000
5.	Customs Duty at 10%	550,000
6.	Erection Charges	200,000
7.	Unforeseen and Sundry Charges ...	500,000
8.	Working Capital	2,500,000
9.	Brokerage, Underwriting Commission and Promotion Expenses ...	250,000
	Total	10,000,000

The Cost of Production of Yarn

1.	Cost of chemicals and raw materials ...	5·10 as. per lb.
2.	Cost of power	·70 " " "
3.	Cost of heating	·45 " " "
4.	Cost of labour	·50 " " "
5.	Cost of staff	·46 " " "
6.	Cost of depreciation charges ...	·96 " " "
		8·17 " " "

India is one of the important textile manufacturing countries of the world and is expected to remain so in future. Textile industry is one of her few important industries whose promotion and expansion should be the concern of all industrialists of this country, and also of the Government. Introduction of artificial silk has revolutionized several aspects of the textile industry and Indian manufacturers have also shown readiness to consume this artificial fibre in ever increasing amount. The growing demand for rayon and the present heavy drainage of money involved in its import from Europe and America are sufficient plea for the immediate setting up of this industry, for which India offers reasonable opportunities.

S. N. Sen.

DEVELOPMENT OF INLAND FISHERIES AS POSSIBLE SOLUTION OF MEAT SHORTAGE

S. L. HORA,

DIRECTOR OF FISHERIES, BENGAL

ADMITTEDLY at the present moment, India as a whole, and Bengal in particular, is faced with the problem of meat shortage. It is pertinent, therefore, to recall how Egypt solved an identical problem in the early years of the war by the development of its inland fisheries. In the *Statesman* of 23rd April, 1942, it was stated:

"Egypt's manner of facing the food problem has interest for India now that central and provincial resources are being reorganized for a 'Grow More Crops' campaign. Egypt's meat shortage problem was so acute that sales were prohibited on three days in the week. This has largely been solved by the development on a remarkable scale of inland fisheries. With the outbreak of war Egypt's fish supply dropped from about 12,000 tons a year to 2,000 tons because of restrictions that had to be imposed on the activities of foreign fishermen. The Department of Fisheries however transferred millions of small fish from the sea to the lakes and the result has been an increase to as much as 40,000 tons a year in supplies."

Through the kindness of Dr Taha, Director of Fisheries, Egypt, I have obtained further details of this remarkable achievement and as the information is likely to prove of great value to all provinces and States, I take the liberty to publish it here in detail so that in this country also development of fisheries may receive the necessary impetus in the "Grow More Food" campaign. Dr Taha has written to say:

"at the beginning of outbreak of this war, the production of the Egyptian Fisheries was seriously affected due to

(1) Restrictions imposed on Sea Fisheries.

(2) About 40 foreign motor fishing boats departed as soon as hostilities began. The few native motor boats left were made use of in purposes other than fishing operations. Consequently the production of sea-fisheries dropped from about 12,000 tons to nearly 3,000 tons annually.

The pre-war total production of the Egyptian Fisheries was estimated at 40,000 tons annually drawn from the three main sources:

(*a*) Marine Fisheries, responsible for 25%--30% of the total production.

(*b*) Lake Fisheries, responsible for about 60% of the total production.

(*c*) Inland Fisheries, responsible for about 10%--15% of the total production.

In addition to the war consequences on sea-fisheries, there are other local factors, which tend to limit the yield of Lake-Fisheries. These mainly are:

1. The area is gradually decreasing and the dried land are reclaimed for Agriculture.

2. Quantities of fresh water supply lakes are gradually decreasing according to the agricultural policy. Consequently the level of the lakes is purposely made as low as possible for the adequate drainage of neighbouring agricultural lands. Moreover the development of agriculture has had not only a bad effect on lake fisheries, but also on the the inland fisheries due to the necessity of controlling and development of irrigation and drainage systems by the construction of dams, barrages, etc. and also the gradual change of vast areas of Upper-Egypt basins from seasonal to permanent irrigation. These vast basins were considered to be one of the best environments suitable for natural breeding and for the raising up of fresh water fish.

3. Confronting the above-mentioned unfavourable factors, the Department of Fisheries tried hard to maintain the production at its pre-war level. The most successful measures to overcome these difficulties were found in extending the operations of transferring millions of fry of marine fishes, mainly Mullets and Anguilla, from certain localities near the sea-shore to the lakes. In particular, we mention Lake Mariout which has no connection with the sea. Lake Karoun, an Inland Lake also used to be rich in fresh water fishes; but due to the agricultural policy, mentioned above, the salinity of its water gradually increased until it is estimated at present at about 20% in the larger part of its area. This high salinity has depleted the lake from most of its fresh water species, and the catches were affected to such an extent that they dropped from 4,100 tons in 1920 nearly to 483 tons in 1929.

4. The introduction of fry in this lake has greatly improved the situation and the catches gradually increased to about 2,782 tons in 1936.

5. It is here interesting to note that besides the successful acclimatization of two species of grey Mullets—Mugil cephalus and Mugil capito—in Lake Karoun, the latter sp. M. capito has definitely spawned and propagated itself in that lake."

Similar causes have affected the supplies of fish in certain parts of India, and for these reasons steps taken in Egypt to augment supplies have practical application to Indian conditions. The fry of various types of mullet are found in large numbers in the estuaries and backwaters and along the sea coast of India. Devanesen and Chacko[1] have already shown that fry of the marine species, *Mugil troschelii*, *M. waigiensis* and *M. seheli* can be successfully acclimatized to fresh water conditions for cultural purposes. Regarding *M. troschelii*, the authors have stated that "Capacity of acclimatization, rapidity of growth, non-cannabalistic habit and the availability

[1] Devanasen, D. W. and Chacko, P. I.—"The Possibility of Culture of certain Marine Mullets in Freshwater Tanks". *Proc. Nat. Inst. Sci. India*, 9, 249, 1943.

of the fry in large numbers indicate that this marine mullet is a good Indian sea-fish for cultivation in fresh waters".

At the end of Devanesen and Chacko's article, in an editorial note it was pointed out by me that in the estuaries of the Ganges *M. tade* and *M. parsia* are extensively cultured in the salt-water embanked fisheries known as 'Bhasa Badha'. Further, it is known in the Sundarbans that Mullets grow to a big size only if allowed to enter into fresh waters, especially in the second year of their growth. Facilities are generally provided for the Mullets to migrate into paddy fields or adjoining freshwater canals for fattening purposes. In the estuaries, however, the change in salinity is more or less gradual and, therefore, the fry of Mullets get conditioned under natural conditions for life in fresh waters. It must be remembered that during the breeding period of Mullets (February to April in Bengal), the waters are simply thick with their fry so that only a little trouble has to be taken in collecting and planting the fry into suitable places of water. It was rightly surmised then that the small marine fish of Egypt transferred to lakes were probably the young of Mullets.

Extension of 'Bhasa Badha' or salt-water *bheris* in the deltaic regions of the principal rivers of India is a practical proposition and is likely to result in a great increase in fish supplies of the country. So far as the real fresh waters in the interior are concerned, fry of carp should be collected from rice fields, inundated channels, and pools and puddles in the flooded areas and transferred to tanks and lakes. Species like *Catla*, *Rohu* and *Mrigal* fatten well under suitable conditions and, if properly farmed, will help materially in solving the meat shortage problem in the country.

HINDU ASTRONOMY*

PRABODH CHANDRA SEN GUPTA

Hindu Mathematics

In Hindu Mathematics, the earliest researcher was Colebrooke whose work is now regarded as a classic in this subject. This work presented to the European scholars the whole content of Hindu Mathematics as contained in Bhaskara II's (1150 A.D.) works, the '*Līlāvatī*' and the '*Bījagaṇita*' and the mathematical chapters of the '*Brāhma-Sphuṭa Siddhānta*' of Brahmagupta. Dr Kern brought out his edition of the '*Āryabhaṭīya*' in 1874. Rodet translated and published one section, the *Gaṇita* of this work into French under the name '*Calcul du Aryabhata*'. Dr Bühler published his work '*Indian Paleography*' in the latter half of the last century. In this work he established from Subandhu's work, dated about the sixth century A.D., the use of a symbol for a vacant notational place, *viz.*, the cypher which was a dot in the poet's time as evidenced by the expression '*Sūnyabindavaḥ*' or the *dots* to which the stars in the sky are compared. In the '*Āryabhaṭīya*' (499 A.D.), the notational places are found mentioned as "sthāna" which means none else than *place*. In this work are found the Indian rules for finding the square and cube roots of numbers, which show unmistakable use of notational places. The late Mr Kaye, in his translation of the *Gaṇita* section of the '*Āryabhaṭīya*', used the word "Order" in place of Āryabhaṭa's word "sthāna", and he created quite a diversion by asserting that the Decimal System of Notation was not an invention of the Indian Mathematicians but had a foreign origin derived from the practice of writing from the right to the left which obtained there. This view of Kaye has been successfully combated by the researchers Dr B. B. Dutt, Dr A. N. Singh and late Prof. Sarada Kanta Ganguly.

From the field of Orientalia, the Decimal System of Notation is the greatest gift of the Hindu Mathematicians to humanity. After the conquest of Sind by Mohamad Ibn Kasim, it travelled to the old centre of Mohamadan culture at Baghdad and with the rise and spread of Mohamadan power it spread over Europe. It has immensely simplified the art of calculation all over the world. In India this system was confined to the learned circles alone for some centuries even after the time of Āryabhaṭa I, till it found a place also in Indian Epigraphy. Dr B. B. Dutt published his '*Science of Sulva*' in 1932, in which we find that the beginnings of many topics in the later Hindu Mathematics had been made in the *Śulva* period, *i.e.*, about 600 B.C. In the solution

* Being the Presidential Address delivered at the Technical Sciences Section of the Twelfth All-India Oriental Conference held at Benares on January 1, 1944.

of Indeterminate Equations of the first and second degrees the achievements of the Hindu mathematicians are also very remarkable. The method employed in solving Indeterminate Equations of the first degree is called '*Kuṭṭaka*' or pulveriser. This method in the complete form is found in the '*Āryabhaṭīya*' (499 A.D.), while in Bhāskara II (1150 A.D.) we have a full treatment of all classes of Indeterminate Equations of the first degree. The famous lemma of Brahma Gupta (628 A.D.), called by him '*Vajrabadha*' was rediscovered by Euler (1707-83) and this method was used by Brahmagupta in solving Indeterminate Equations of the second degree and also by the later Hindu mathematicians in solving comparatively easier problems. The Indian method of *Cakravāla* or the "cyclic method" for the general solution of all Indeterminate Equations of the second degree, following as a corollary* to the lemma of Brahmagupta to whom the credit of its invention which is purely Indian is to be ascribed has yet remained a riddle to many. The rules are found in Bhāskara II's work the '*Bījagaṇita*', but the author lays no claim to originality, when he says "*cakravālamidaṁjaguh*". This has been sung (by others) as the "cyclic rule". Thus far it can be said that the rules have not yet been found in any hitherto known previous authors. I hope that further researches may show that this achievement is to be ascribed to Padmanābha, if his work be ever brought to light. It is now a matter for research to decide whether the Hindus were also the first to use a symbolical notation in Algebra.

In Trigonometry, the Hindu mathematicians and astronomers used generally the functions of "sine", "cosine" and "versed sine" in analysis. The tabular differences of 24 "sines" in a quadrant are first found given in '*Āryabhaṭīya*' (499 A.D.) calculated by the most elementary methods. The most accurate Hindu value of π is also found in the same work as given by $\pi = \frac{104 \times 8 + 62000}{20000} = 3.1416$. The Hindus by their methods, though very elementary, could solve both plane and spherical triangles† right angled and of other classes. Further in Hindu Mathematics we find the beginnings made of the Infinitesimal Calculus. The researchers in this field have been Bāpudeva in *J. A. S. B.*, (1858) and Sir B. N. Seal in his "Positive Sciences of the Hindus". I have also contributed a paper in the *Calcutta University Journal of Letters*, Vol. XXII, 1931, styled "Infinitesimal Calculus in Indian Mathematics and Astronomy". The idea of Differentiation developed from an attempt of the Hindu astronomers to find the instantaneous daily motion of planets, and the idea of Integration, to find the surface and volume of a sphere, etc. So far as we can see, in Differentiation the idea of limits was recognized by all authors from Brahmagupta (628 A.D.) to Bhaskara II (1150 A.D.). The idea of the real Differential Calculus thus seems to have originated in India. We have in Bhaskara II an equation which is equivalent to

$$d(\text{Sin }\theta) = \text{Cos }\theta\ d.$$

While engaged in translating Brahmagupta's *Khaṇḍakhadyaka*, the *Alarkand* or *Khaṇḍakaṭaka* of the Arab astronomers, I came across a passage which, properly interpreted, makes it clear that Brahmagupta recommends the use of the Second Difference in Interpolation. On this topic a paper was published by me in the *Bulletin of the Calcutta Mathematical Society*, Vol. XXIII, 3, 1931. It will be clear from my paper under reference that, of the Calculus of Finite Differences also, the first step was taken by the Hindu mathematicians.

Drs Dutt and Singh have undertaken to publish a complete anthology of Hindu Mathematics, of which up to now the first two volumes have been published, and the third volume is under compilation. I trust, when the times are more favourable, these volumes, it is expected, will give the reader a complete history of Hindu Mathematics and all researches thereon up-to-date. If such a private venture is to prove successful, liberal help from the public or a university is perhaps essential. From the very nature of such publications, the venture cannot be remunerative.

In this connection we should not forget to mention the name of Prof. Rangacharya of Madras, the translator and publisher of the '*Gaṇita Sāra Saṁgraha*' of Mahāvira. The work has thrown much light on Jaina Mathematics and has been of much help in the study of the history of Hindu Mathematics. The researches of Prof. A. A. Krishnaswami Ayyangar of the Maharaja's College, Mysore, also deserve mention. I now pass on to the progress made on the study of the history of Hindu Astronomy.

Hindu Astronomy

In this branch of Orientalia, the earliest writers were Bailly in his '*Astronomie Indiennie*' and Delambre in his classical work '*Astronomie Ancienne*'. Next in point of time was probably Bentley whose work, "*A Historical View of Hindu Astronomy*", is well known. Then came the edition of the '*Sūrya Siddhānta*' by Bapudeva and Wilkinson. Warren's '*Kāla Saṁkalita*' was perhaps next to appear in this field of research. In 1860 was published Burgess' translation of the '*Surya Siddānta*', in the

* P. C. Sen Gupta, "Origin of the Indian Cyclic Method for the solution of $Nx^2+1=y^2$" in the *Bulletin of the Calcutta Mathematical Society*, 1918.

† P. C. Sen Gupta, "Greek and Hindu Methods in Spherical Astronomy" in the *Cal. Univ. Journal of Letters*, Vol. XXI, 1931.

J. A. O. S. A more important work from the view point of the history of Hindu Astronomy next appeared in the publication by Thibaut and Dvivedi Varāha-Mihira's *'Pañca-Siddhāntikā'*, which threw much more light on the history of the *Siddhāntic* or scientific Hindu Astronomy. About the end of the last century appeared the *'Gaṇaka Taraṅginī'* (1892) of Dvivedi in Sanskrit, Dīkṣita's *'Bhāratīya Jyotiḥ-śāstra'* (1896) in Marathi and *'Amader Jyotiṣa o Jyotiṣi'* in Bengali by Prof. J. C. Ray, late of the Cuttack College, being mainly based on the works of Dvivedi and Dīkṣita. These works should all have been written either in Sanskrit or English and not in any of the provincial vernaculars.

In the year 1918, Ancient Indian History and Culture was accepted as a subject for the M.A. degree of the Calcutta University at the instance of the late Sir Ashutosh Mookerjee, and Indian Astronomy and Mathematics was formed into a group for special study for this final degree of the University. From this date both teaching and research were provided for in the Calcutta University. In 1925 appeared an edition by Pandit Babuaji Misra of the *'Khaṇḍakhādyaka'* of Brahmagupta with Āmaraja's commentary. This publication led me to get at the clear position of Āryabhaṭa I as the real maker of the Indian Scientific Astronomy in a publication of mine, "Aryabhaṭa, the Father of Indian Epicyclic Astronomy" published in the *Calcutta University Journal of Letters*, Vol. XVIII, 1928. The other publications by me have been the papers :—

(*a*) A translation of the *'Āryabhaṭīya'* in the *Calcutta University Journal of Letters*, Vol. XVI, 1927, (*b*) Āryabhaṭa's method of determining the mean motions of planets, in the *Bulletin of the Calcutta Mathematical Society*, Vol. XII, 3, (*c*) Time by Altitude in Hindu Astronomy and (*d*) Hindu Luni-solar Astronomy in the *Bulletin of the Calcutta Mathematical Society* in Vols. XVIII and XXIV respectively. The Introduction to the Calcutta University reprint of Burgess' translation of the *'Surya Siddhānta'* published in 1935, has been my last published contribution to the History of Hindu Astronomy.

As to the Hindu *Siddhāntic* Astronomy foreign influence is unquestionable as may be seen from the brief and meagre account of Greek Luni-solar Astronomy under the name *'Romaka Siddānta'*, given in the *'Pañca-Siddhāntika'* of Varāhamihira. The *'Vaśiṣṭha'* and the *'Pauliśa Siddhāntas'* of which a summary is given in the same work of Varāhamihira, also point to a foreign origin which may be Greek, Babylonian or Persian. Even the modern *'Sūrya Siddhānta'* has in it the unmistakable influence of Babylonian Astronomy in its conception of the gods of *Manda*, *Sighra* and *Pāta*, as producers of planetary *dhānta.'* The chief improvements made by Āryabhaṭa are given in the following tabular form :—

Inspite of all these foreign influences *Āryabhaṭa* I (499 A.D.), the real maker of the Indian Scientific Astronomy had a clear originality in a thorough revision of all the astronomical constants as they came from the foreign sources. These have been set forth in my paper *"Hindu Luni-solar Astronomy"* and in my Introduction to the Calcutta University reprint of Burgess' translation of the *'Sūrya Siddhānta.'* The chief improvements made by Āryabhata are given in the following tabular form :—

Astronomical constants	Aryabhata 499 A.D.	Ptolemy 150 A.D.	Moderns 500 A.D.	Aryabhata's Error	Difference from Ptolemy
Longitude of Sun's Apogee	78°	65° 31′	77° 19′	+ 0° 41′	+12° 30′
Sun's max. Equation of Apsis	2° 9′	2° 23′	1° 59′	+ 0° 10′	- 0° 14′
Sid. Per. of Moon's Node	6794·7459 da.	6796·4558 da.	6793·3911 da.	1·3584 da.	−1·7063 da.
Long. of the Aphelia of					
(*a*) Saturn	236°	224° 10′	243° 40′	- 7° 40′	+11° 50′
(*b*) Jupiter	180°	152° 9′	170° 22′	+ 9° 38′	+27° 51′
(*c*) Mars	118°	106° 40′	128° 28′	10° 28′	+11° 20′
Long. of Nodes of					
(*a*) Saturn	100°	90°	100° 32′	− 0° 32′	+10°
(*b*) Jupiter	80°	70°	85° 13′	− 5° 13′	+10°
(*c*) Mars	40°	30°	37° 49′	+ 2° 21′	+10°
(*d*) Venus	60°	55°	63° 16′	− 3° 16′	+ 5°
(*e*) Mercury	20°	10°	30° 35′	−10° 35′	+10°
Max. Equation of Apsis					
(*a*) Saturn	7° 53′	6° 30′	6° 57′	+ 1° 4′	+ 1° 23′
(*b*) Jupiter	5° 24′	5° 14′	5° 16′	+ 0° 81′	+ 0° 10′
(*c*) Mars	10° 28′	11° 10′	10° 33′	+ 0° 55′	+ 0° 9′

Here the differences between the constants of Āryabhaṭa I and Ptolemy cannot be explained by the precession rate of Ptolemy of 1° per 100 years in the cases of the longitudes of aphelia and nodes of planets, while in the remaining cases independent determination by Āryabhaṭa I must be conceded. These facts ought to be enough proof of the claim for Āryabhaṭa I, being held as the greatest of all the ancient Indian astronomers, as the real maker of the Indian *Siddhāntic* Astronomy, and not a mere borrower from any foreign system of astronomy.

Again the teaching in Hindu Astronomy that at starting point of the Kali-reckoning, the "mean planets" were at the very beginning of the Hindu sphere and that the longitudes, the moon's apogee and node were respectively 90° and 180° of the same sphere, is also to be ascribed to Aryabhata I. The epoch of Kali-reckoning, *viz.*, Feb. 17-18, 3102 B.C., Ujjayini Mean Time, 0 hr. or 6 A.M. of Feb. 18, was most likely arrived at by him by an Indeterminate Analysis. Although at this epoch the "mean planets" did not exactly coincide with the 1st point of the Hindu sphere (the mean vernal equinox of 21st March, 499 A.D.) and the lunar apogee and the node did not have the longitudes 90° and 180° of it, there was something approaching a general agreement with the hypothesis with which Aryabhata I had started. This is borne out by the researches of Bailly, Bentley, Burgess and also by myself. It is thus seen that the astronomical Kali-reckoning was a fiction created by Āryabhaṭa I to simplify his rules for stating his astronomical constants at this epoch. It is clear from the facts stated above that this epoch of 3102 B.C. cannot have any chronological significance.

But as we come down by 3600 years from this Kali epoch to Aryabhata's time using his constants, to the date, March 21, 499 A.D. Ujjayini Mean Midday, (J.D. = 1903397), we have :—

The figures show to some extent how far Āryabhaṭa I was accurate as an observer.

Again Āryabhaṭa's year = 365da. 6 hrs. 12 min. 30 secs. and True Sid. year = 365da. 6 hrs. 9 min. 10 secs.

His year was thus in error by about + 3 min. 20 secs. But *Pauliśa Siddhānta* year = $\frac{120}{43831}$ days = 365 da. 6 hrs. 12 mins., which was more accurate but still Āryabhaṭa I, perhaps did not find it to have been so. He did not accept any astronomical element transmitted from a foreign source as correct until and unless it was verified by his own observation or observation records accessible to him.

As to the discovery of lunar inequalities, Āryabhaṭa I (499 A.D.), Brahmagupta (628 A.D.), Lalla (748 A.D.), recognised only one. But on coming down to the time of Muñjāla (932 A.D.) we find that this astronomer first discovered the second inequality of the Moon* and Bhāskara II (1150 A.D.) the third inequality. The Hindu form of the "evection" equation is much better than that of Ptolemy and stands on par with that of Copernicus (1542 A.D.)

The other details of Hindu astronomy chiefly concerned with the Hindu astronomical methods of calculation, were improved upon and corrected by Brahmagupta and Bhaskara II. Periodical corrections to planetary positions as derived from the *Siddhāntas*, have been made by Lalla, Sripati, Satānanda, Bhaskara II, Ganesa and Makaranda and in Bengal by Raghavānanda and Rāmaśarma. They have also derived simpler methods of calculation according to the *Siddhāntas*. The outstanding fact from all researches up to date is that the first Hindu scientific *Siddhānta* the *Āryabhaṭiya*, was started from the year 499 A.D. and by Āryabhaṭa I.

From the view point of the history of Hindu astronomy, there is a great gap from about 1400 B.C. to 499 A.D., which remains yet to be explored I

* On this topic two papers have been published in the *Bulletin of the Calcutta Mathematical Society*, one in Vol. XXII, 2 and 3 by Mr Dhirendra Nath Mukhopadhyaya, and the other in Vol. XXIV, 1, by the writer named "Hindu Luni-Solar Astronomy".

Planet	Āryabhaṭa's Mean Long. Addayika	Mean Trop. Longitudes Moderns	Error in Āryabhaṭa's Mean longs.	Āryabhaṭa True Places	Moderns True Places	Error in Āryabhaṭa's True Places
Sun	0° 0′ 0″	359° 42′ 5″	+ 17′ ″55	2° 6′ 6″	1° 37′ 48″	0° 28′ 18″
Moon	280° 48′ 0″	280° 24′ 52″	+ 23′ 8″	..	...	...
Moon's Apogee	35° 42′ 0″	35° 24′ 38″	+ 17′ 22″	...	...	..
Moon's Node	352° 12′ 0″	35° 2′ 26″	+ 9′ 34″	...	..	...
Mercury	186° 0′ 0″	183° 9′ 51″	+2° 50′ 9″*	352° 4′	349° 4′	+3° 0′*
Venus	356° 24′ 0″	356° 7′ 51″	+0° 16′ 9″	359° 43′	359° 18′	+ 25′
Mars	7° 12′ 0″	6° 52′ 45″	+0° 19′ 15″	10° 50′	10° 23′	+ 27′
Jupiter	187° 12′ 0″	187° 10′ 47″	+ 0° 1′ 13″	185° 57′	186° 40′	- 47′
Saturn	49° 12′ 0″	48° 21′ 13″	+0° 50′ 47″	40° 5′	40° 56′	− 51′

* Maximum error in the long. of Mercury in Āryabhaṭa's system.

mean the period of transition from the astronomy of the *Vedāṅgas* to the age of the *Siddhāntas*. In this period lived the astronomers Garga, Kasyapa, and others whose names and extracts from whose works are quoted by Bhattotpala (966 A.D.) in his commentary on the *Bṛhat Saṁhitā* of Varāhamihira. There are works like the *Vṛddha Garga Saṁhitā* still extant, which should be rescued from the total oblivion into which they are fast sinking. These astronomers described *cāras* or courses of planets of which we get some idea from the *Pañca-Siddhāntikā*, chapter XVII, and also from the *Arthaśāstra* of Kautilya. It is a very important point for research how far these *cāras* described in these earlier works, could have influenced the first formation of the scientific Hindu Astronomy by *Āryabhaṭ I*.

EDUCATIONAL NEEDS OF BENGAL BASED ON FIGURES OF EMPLOYMENT

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Introductory

THERE are various ways by which the educational needs of a country can be surveyed. A practical method of doing it will be to calculate backwards from the figures of employments. Just as the success of an individual depends on how best he can conserve his energy and apply it to different activities of life according to demands, so does the success of a nation depend on how best it can conserve the total energy of its individuals for expenditure in the varied activities of the national life. This requires a careful planning and grouping of the individuals so as to obtain the maximum of collectivized efficiency at minimum of expenses and this is possible only by educating the groups in such a way that excesses are avoided and standards improved. It is necessary to avoid excesses not merely because all excesses are wasteful but because with limitations of human energy and of national income such excesses are bound to lead to inefficiency in training and deficiency in the standard of education.

What has been meant here by excesses in education is this: To a clerical post it is wasteful to employ a person having a high literary education. It is not that the latter person will be incompetent to do the work—though at times this is also true—but in order to avoid wasteful utilization of national energy such a person should not be employed for doing the work of a clerk but should be given some vocation in which his literary abilities might find a fair play. For efficient conservation of the nation's energy, in choosing a clerk we ought to choose a man who has the right training and equipment of a clerical job and it should be the duty of the nation to give a number of men the requisite training so that they might be suitably employed for such vocations. Similarly a *Jotdar* ought to receive sufficient training in scientific agriculture and not made to receive a purely academic training which will lead him nowhere.

It is therefore clear that in formulating our educational needs, the most scientific way of approach will be to examine the country's requirements from the vocational standpoint. It is true that such requirements have no static feature and are directly connected with the nation's outlook. In the predominantly agricultural Tsarist Russia probably 90% of the people of Russia had agriculture as their vocation, whereas in the modern industrialized Soviet Russia a considerable number has changed their vocation from agriculture to industries. Consequently the educational needs of modern Russia differ considerably from those of the past. There is however a limitation to such changes and fluctuations and in any case in making a start, the existing condition may safely be regarded as an index of the country's present requirements, and it may be surveyed every five or ten years when requisite statistics are available from census figures. A more accurate and thorough plan would have been to find out the optimum of each vocation, *i.e.*, the number of men which each vocation can suitably accommodate without any overcrowding. But necessary data for calculation of the optimums are not available, hence the actual figures of employments have been accepted as the optimum of the corresponding vocation.

With the above in view, a thorough analysis of the figures of employments of male populations of Bengal has been made from the Census Report of 1931—those of the 1941 Census being not yet avail-

able and women's education has been left out of the present consideration. Such analysis at once reveals that persons employed in different pursuits can be suitably classified from the educational standpoint into the following three groups:—1. General, 2. Commercial, 3. Technical. From the number of persons employed, an estimate has been made as to the number of probable annual vacancies and this latter figure has been utilized in the calculation of the number of schools of each type required to satisfy the country's requirements on the assumption that the basic education of the different groups is common in Primary and in some length, of the High School stage.

TABLE 1

ANALYSIS OF THE EMPLOYMENT FIGURES

Estimated figures requiring education (in thousands)

Vocation as classified in the Census Report	*Total employed in 1000*	*General*		*Commercial*		*Technical*		*Remarks*
		Low	*High*	*Low*	*High*	*Low*	*High*	
1 Non-cultivating proprietors ...	451·7	406·6	36·1	...	4·5	...	4·5	
2—3 Estate Agents and Managers .	1·1	. .	1·1	...	...	...	...	
4 Rent Collectors	42·3	.	...	42·3	...	...		Rest
9—16 Special Cultivation	146·6	1·0	·12	...	·1	·2	·1	Labourer
17 Forest Officers, rangers, guards ..	1·1	...	·2	...	·12	·12	·1	Do
43 Cotton spinning, sizing & weaving ...	127·7	1·4	0·2	·2	. .		·24	Do
35 Coal	24·3	...	...	·24	...	...	·24	
44 Jute pressing, spinning & weaving ...	229·1	1·1	0·3	·3	·15	·3	·15	
51—53 Hides Industry: Leather, bone ...	11·2	·4	·1	·1	...	...	...	
54—56 Wood: Sawers, Carpenters, Basket-makers	116·6	3·0	·5	·5	...	·5	...	
57 61 Metal: Smelting, Blacksmith, Brass workers	48·5	3·4	·5	·5	..	·5	...	
53 66 Ceramics: Potters, Brickmakers, other ceramics	63·2	·8	·2	·2	...	·2	...	
66 · 70 Chemical products: Matches, Aerated Water, Vegetable oil, Mineral oil	35·4	...	...	·2	...	·1	·1	
82 84 Dress and Toilet	61·6	·6	...	·6	...	·6	...	
88 Cabinet maker	1·8	...	...	·1	..	·1	...	
6 99 Miscellaneous Industries	59·1	2·1	...	1·9	...	1·9	·08	
91 Motor car construction and repair ...	1·7	...	...	·08	...	·34	...	
92 Carriage	1·1	...	. .	·02	...	·11	...	
94 Electric Power and Gas work ..	3·3	...	...	·06	...	·25	·06	
112 Ry. Employees excepting labourers ...	38·6	14·5	4·8	7·3	2·4	7·3	2·4	
107 Employees of Mechanical Vehicles ...	8·2	...	...	1·0	...	3·1	...	
114 Post, Telegraph, Telephone employees	10·6	3	3	2	1·0	1·0	·6	
115 Bank, Insurance employees . .	44·4	...	·4	30	10·0	...	...	
116 Brokers	8·8	...	.	7	·8	...	...	
117 Textile Trade	56·5	...	2·8	25·4	...	...	...	
118 Leather Trade	22·7	...	·2	2·1	...	...	...	
123 Other Trades	170·0	...	·8	14·4	..	...	·8	
125 Trade in Chemicals	3·5	...	·8	1·0	...	...	...	
148 Book Trades	22·5	5·0	1·2	5·0	..	...	...	
153 Army (Imperial)	2·5	2·0	0·5	...	..	...	...	
157 Police	21·2	19·2	2·0	...	...	...	...	
158 Village Watchmen ...	33·5	33·5	...	...	...	...	...	
159 State Service	38·5	...	35·0	...	3·5	...	...	
161 Municipal	9·2	...	8·5	...	·8	...	...	
162 Village Officials	1 1	1·1	...	...	...	...	..	
167 Lawyers	17·1	...	17·1	...	...	...	...	
168 Lawyers' Clerks	13·5	13·5	...	..	...	...	...	
169 Medical Practitioner	28·7	...	28·7	...	...	...	...	
170 Quacks	21·3	21·3	...	...	...	...	...	
171 Dentists	1·1	...	1·1	...	...	...	...	
173 Vet. Surgeons	·5	...	·5	...	...	...	...	
174-176 Professors & Teachers including Clerks etc. in Institution ...	69·0	...	69·0	...	...	...	. .	
177 Surveyors & Engineers ...	1·6	...	1·6	...	..	...	...	
178-183 Miscellaneous occupation in Arts & Sciences	22·8	20·4	2·4	...	..	...	...	
186 Motor Drivers & Clearers	7·2	...	...	...	...	3·6	...	
188 Unclassified businessmen	6·7	3·0	·7	3	...	...	...	
189 Cashiers & Accountants	194·4	...	...	175	19·4	...	...	
190 Mechanics	9·0	...	...	...	...	8·0	7·0	

N.B.—By "High" and "Low" are meant the corresponding education of the College and School standards respectively.

It is amazing that out of a population of over 4½ crores (1931 Census figure) number of persons engaged in vocations requiring secondary or higher education is as low as 1·18 millions. Be that as it may, the total number of persons requiring different types of education, as enumerated in the "Analysis of the figures of employments" given above, may be broadly classified as below:—

TABLE 2

Type of education		*No. of persons in thousands*
General low	...	556·9
General high	...	221·5
Commercial low	...	320·6
Commercial high	...	42·5
Technical low	...	28·2
Technical high	...	10·2
Total	...	1179·9

The rest of adults comprising the large volume of cultivators, fishermen and labourers need only be given Primary education with adequate vocational bias. As the complicated question of Primary education is left out of the present consideration, the analysis of the educational needs of Bengal will therefore be confined to Secondary and Higher education only.

Analysis of the Educational Needs

The figures collected above give the total number of persons engaged in vocations requiring a common basic type of education. It may be argued that the allocation to different groups has been done entirely arbitrarily. Although this is true, it may be claimed that in many cases test verifications have been made by references to particular firms representing a group and the percentage of figure of allotment to different classes has been adjusted accordingly. Consequently the figures are not obtained on an entirely arbitrary basis but has close correlation with the actuals.

Assuming therefore that each vocation can support only the present number of persons, it is clear that *for the present*, the educational aim of the country should be to keep an adequate supply of trained men so that these figures, which would normally run short by death or retirement can be maintained at their present levels. Now, persons engaged in any vocation comprise all age groups, say between 18 and 60. Taking 18 as the average minimum age of entry and 60 as the average maximum age of retirement from service,* the defection due to retirement may be estimated by assuming an equi-distribution of number in different age groups, so that the number of retirement in any year is the total number divided by the number of years of active service. This gives the percentage of vacancy by retirement as 100 divided by 42 (60 − 18) *i.e.*, 2·4.

The defection due to death* may be obtained from the Indian mortality co-efficients for the said age limits and taking their average as shown in the table 3 below:

TABLE 3

Age				*Value of co-efficient per hundred*
20	...	...	...	... ·5
30	...	...	...	... ·7
40	...	...	...	... 1·0
50	...	...	...	... 1·5
60	...	...	...	... 2·9
Average	...	...	...	... 1·37

The total co-efficient of defective is thus 2·4 + 1·37 = 3·77. Hence the number of persons of each education-group required to balance the annual defection is as follows. (Table 4).

TABLE 4

Type of Education	*Total No. employed in thousands*	*Defection Co-efficient*	*No. of defection = Col. 2 × col. 3 divided by one hundred*
General (low) ..	556·9		20998
,, (high) ..	221·5		8350
Commercial (low)	320·6	3·77	12086
,, (high)	42·5		1602
Technical (low)	28·2		1063
,, (high)	10·2		384

Consequently the needs of the Secondary and Higher education will have to be formulated in such a way as to impart different types of education to such number of persons as will annually yield the number given above.

Although a classification into different types according to the requirements of each vocation has been made, it will be generally admitted that in the elementary stages they must be the same and the branching into different types should take place at some higher stages of the school education. There may be some difference of opinion as to the stage at which this will happen. But from consideration of age it may be laid down that such branching leading to some degree of specialization will not be of advan-

* Although the age of retirement in State services is 55, as the number of persons engaged in State services is very small as compared to the total, the average age of retirement is estimated at 60, which may be regarded as the age at which infirmity begins.

* Defection co-efficient by death should vary according to nature of occupation but owing to absence of such classification in the Mortality table, the average is taken.

tage until at least the age of twelve is reached which corresponds to Class VIII of High Schools taking the average age of admission into the lowest class (*i.e.*, Class III) as seven years. A general scheme of education is accordingly tentatively suggested in the form a genealogical table given below:—

TABLE 5

Elementary School Education A.
(Up to Class VII).

High School Education leading to Matric General	Technical School Education B leading to Matric technical	Commercial School Education B leading to Matric Commercial
University General	Technical high	University Commercial

Assuming the average defection in class promotion as 4% and the defection in the first stage, *i.e.*, from A to B as 20%, from B to C as 30% a progressive loading backwards has to be made in order to arrive at figures giving the number of students in the topmost class of stage A which will satisfy our vocational needs. This has been shown in the following table.

TABLE 6

Type		*No. of persons of Table 4.*	*No. of Matrics required for col. 2 at 30% defection.*	*No. in hundreds in lowest stage in B at 12% defection.*		*No. in hundreds in the highest stage in A at 20% defection.*	
General high	..	8,350	11,930	135	373	170	467
,, low	..	...	20,998	238		297	
Commercial high	..	1,602	2,290	26	163	32	202
,, low	..	.	12,086	137		170	
Technical high	..	384	550	6	18	8	23
,, low	..	...	1,063	12		15	
							692

The number of students which institutions imparting different types of education will have to pass out annually being thus known, an estimate of the total number of such institutions can be made, as is given in the table below:

TABLE 7

Type of Education	*No. to be catered for the end class in hundreds*	*No. of institutions required at an average of 30 students in the end class*	*Type of institution*
General (elementary)	692	2,307	A type.
General (Matric)	373	1,240	B type general
Commercial ,,	163	543	Commercial B
Technical ,,	18	60	Technical B.

The number of persons required for vocations demanding higher education has been given in column 2 of table 6. This number comprises of all grades of University education from Intermediate to the higher degree examination.

The statistical division of this different grades of higher education has not been attempted here as the main object was to determine the requirements of the Secondary education. Incidentally, however, the statistics so far collected enable us to determine the number of Intermediate Arts Colleges or equivalent Technical Schools as shown in Table 8.

TABLE 8

Type of Education		*No. to be catered for*	*No. of institution required at an average of 100 in the class*	*Type of institution*
General	..	8,350	84	Intermediate Arts College
Commercial	..	1,602	16	Commercial College
Technical	..	384	4	Technical College

Conclusion

The analysis given above with all the limitations of imperfect data shows that the present needs of Bengal may be well served by having about 2,300 elementary schools of type A imparting education up to the standard now reached in Class VII of high schools and 1,240 high schools of the General B type teaching Class VIII to the Matric Standard and these are to be supplemented by 540 high schools of B type giving a commercial bias and 60 similar technical schools. These 1,840 high schools are to feed 84 Arts, 16 Commercial and 4 Technical Colleges giving education up to the Intermediate Standard of the University. As after the elementary stage a branching into different types appear to be necessary from vocational considerations, the completion of the elementary stage should be marked by holding some sort of a distinctive examination either under the control of the University or of a separate Board as may be found convenient. This practically means a revival of the M. E. Schools but with this important modification that they should no longer enter as an alternative to the earlier classes of H. E. Schools as they used to do in the past but they should form an integral part of the school education and their final examination has to be passed in order to qualify for high school education. So far as general education is concerned the elementary schools of type A and the high schools of type B may be housed together

for the sake of economy more particularly in towns and sub-divisions and in progressive villages. But elsewhere only the lower type of schools need be maintained. This will not only reduce the total cost but will also offer distinct advantages to villagers in being able to receive their education at centres nearer to homes.

As the analysis has been made on the figures of 1931 Census when the population was 4·5 crores, with the increase in population by nearly 25% as revealed in the 1941 Census, there must have been a pro-rata increase in the number of employments and the figures arrived at in the present analysis must also receive corresponding increase. That is to say, the total number of elementary schools of type A should be about 2,850 and that of type B general 1,500, type B commercial 650 and type B technical 75.

It must also be distinctly understood that though the present scheme may suffice to serve the present needs of Bengal, a five yearly revision of the scheme will have to be made in order to satisfy the growing demands of the post-war reconstruction period in which an Agricultural India is bound to be gradually transformed if not to an Industrial India but to an India in which industrial and commercial developments will certainly be more marked than developments in any other direction. Education in a progressive country will always be dynamic in character and the static feature which forms the basis of the present analysis can at best represent the condition of things for a limited number of years. For more careful planning better statistics are also needed and Census authorities will certainly render a great service if they care to publish the figures of persons having different standards of education along with employment figures in different vocations.

Notes and News

NATIONAL CHEMICAL LABORATORY

The Committee of the Council of Scientific and Industrial Research appointed to draw up a scheme for the establishment of the proposed National Chemical Laboratory for India has recently submitted its report which is now released for publication to invite public opinion and criticism. The National Chemical Laboratory, as we find from the report, will be established much after the fashion of the chemical research laboratories in Teddington under the Department of Scientific and Industrial Research, England. While fundamental research will form an important part of its programme, greater emphasis will be laid on industrial research and the development of new processes up to the pilot plant stage. Such researches will doubtless be of direct help to chemical and other industries now badly in need of such investigations. Facilities for research up to the pilot plant stage are at present hardly available with the result that a process successfully developed in a laboratory often proves a failure when worked out on a large scale. With the establishment of the National Chemical Laboratory such uncertainties will largely cease to exist and the manufacturers may be encouraged to undertake with greater confidence the commercial development of new processes. The laboratory will further maintain the closest co-operation with the laboratories of the universities or other institutions under private or semi-Government management.

It is proposed that the Laboratory should at present provide accommodation and facilities for the following main branches of chemistry: inorganic chemistry including analytical investigations, organic chemistry including drugs and chemotherapy, physical chemistry including high-pressure technique and electro-chemistry, biochemistry including biological products, and chemical engineering. When facilities for investigations in these branches will be created, it will be possible, the report states, to deal with raw materials and problems relating to a number of industries, such as heavy chemicals (acids, alkali, salts, etc.), minerals, fertilizers, organic and inorganic chemicals including solvents, pharmaceuticals and food, fermentation and biological products, resins and plastics, paints, pigments, lacquers and varnishes, oils, fats, soaps and lubricants, essential oils, leather and adhesives, rubber, petroleum, and electro-chemical industries. It is suggested that provisions for work shops and pilot plant equipment should be satisfactory enough to enable the laboratory to undertake ordinarily any type of industrial research.

The fact that the first step represented by the drawing up of the scheme for the establishment of

the National Chemical Laboratory has now been concluded is an encouraging news. But we are disappointed to learn that the actual establishment of the Laboratory will not take place until after the war. The establishment of the National Chemical Laboratory and similar central laboratories, such as the National Physical Laboratory, the National Metallurgical Laboratory, the Central Fuel Research Station and the Central Glass and Silicates Research Institute, as we have repeatedly stressed, is an immediate and urgent necessity. Substantial industrial development of this country will not be possible so long as these central institutes of research do not come into being and start work. Deferring the establishment of these laboratories means postponement of the urgent industrial development of India which we can only accept at our own peril. Schemes are being framed, adopted and translated into practice in other countries, as the war is in progress, for the intensive development of industries as a measure of national preparedness during this war and more particularly for the post-war period. There is danger in delay when other nations are planning not only for the consolidation of home markets but for the capture and maintenance of foreign markets, and as such the execution of the scheme, we strongly feel, should be undertaken here and now.

INDIAN PHARMACOPOEIA

THE recent decision of the Government of India to publish an Indian Pharmacopoeia is a welcome news. The Government have asked the Drugs Technical Advisory Board to prepare the material for a list of drugs in use in India and to recommend standards and tests with which to establish their uniformity, identity and purity. These drugs, although not included in the British Pharmacopoeia, are of sufficient medicinal value to justify their inclusion in an official pharmacopoeia. The list, when approved, will be known as the Indian Pharmacopoeial List and will constitute the official Indian Supplement to the British Pharmacopoeia.

Considerable material is available as a result of the indigenous drug enquiry which has been in progress for a number of years under the direction of Lt.-Col. Sir R. N. Chopra. Any further investigation that may be necessary to determine the standards to be laid down can be carried out at the Bio-Chemical Standardization Laboratory or, by arrangement, at other Government laboratories. A Committee, with Sir R. N. Chopra as the Chairman, has been set up to examine the material for the list and report to the Board and includes the following members: Dr P. Kutembiah, Dr R. N. Prasad, Dr B. B. Dikshit, Dr A. K. Sen, Mr. S. N. Bal, Mr M. L. Schroff, Dr Sudhamoy Ghosh, Dr B. N. Ghosh, Dr B. Mukerji and Secretary, Drugs Technical Advisory Board.

THE VALUE OF RESEARCH IN PURE SCIENCE

LAST year there was published a biography of the late Sir J. J. Thomson, written by Lord Rayleigh.* It is a book that every research student should read. At the present time, when the question of organizing scientific research in India is receiving so much attention, the following quotation from Lord Rayleigh's biography is well worth reproducing. It relates to an occasion in 1916 when Sir J. J. Thomson, as President of the Royal Society, headed a deputation which was received by Lord Crewe who was then Lord President of the Council. Sir J. J. Thomson delivered a speech which seems to have made a considerable impression. The most significant part of it was as follows:—

"I shall, this morning, look on research in pure science from a frankly utilitarian point of view, not because I think it is the only, or even the most important aspect of the question, but because it is the aspect which must, quite legitimately, appeal most forcibly to the Government responsible for the material welfare of the country.

"By research in pure science I mean research made without any idea of application to industrial matters but solely with the view of extending our knowledge of the Laws of Nature. I will give just one example of the 'utility' of this kind of research, one that has been brought into great prominence by the war—I mean the use of X-rays in surgery. Now, not to speak of what is beyond money value, the saving of pain, or, it may be, of life to the wounded, and of bitter grief to those who loved them, the benefit which the State has derived from the restoration of so many to life and limb, able to render services which would otherwise have been lost, is almost incalculable. Now, how was this method discovered? It was not the result of a research in applied science starting to find an improved method of locating bullet wounds. This might have led to improved probes, but we cannot imagine it leading to the discovery of the X-rays. No, this method is due to an investigation in pure science, made with the object of discovering what is the nature of Electricity. The experiments which led to this discovery seemed to be as remote from 'humanistic interest'—to use a much misappropriated word—as anything that could well be imagined. The apparatus consisted of glass vessels from which the last drops of air had been sucked, and which emitted a weird greenish light when stimulated by formidable looking instruments called induction coils. Near by, perhaps, were great coils of wire and iron built up

* The Life of Sir J. J. Thomson, by Lord Rayleigh, Cambridge University Press, 1943.

into electro-magnets. I know well the impression it made on the average spectator, for I have been occupied in experiments of this kind nearly all my life, notwithstanding the advice, given in perfect good faith, by non-scientific visitors to the laboratory, to put that aside and spend my time on something useful.

"This example illustrates the difference in the effects which may be produced by research in pure or applied science. A research on the lines of applied science would doubtless have led to improvement and development of the older methods—the research in pure science has given us an entirely new and much more powerful method. In fact, research in applied science leads to reforms, research in pure science leads to revolutions, and revolutions, whether political or industrial, are exceedingly profitable things if you are on the winning side.

"Granting the importance of this pioneering research, how can it best be promoted? The method of direct endowment will not work, for if you pay a man a salary for doing research, he and you will want to have something to point to at the end of the year to show that the money has not been wasted. In promising work of the highest class, however, results do not come in this regular fashion, in fact years may pass without any tangible results being obtained, and the position of the paid worker would be very embarrassing and he would naturally take to work on a lower, or at any rate a different plane where he could be sure of getting year by year tangible results which would justify his salary. The position is this: You want this kind of research, but if you pay a man to do it, it will drive him to research of a different kind. The only thing to do is to pay him for doing something else and give him enough leisure to do research for the love of it. Now this kind of research has been done in the past and will, I think, for some time to come continue to be done mainly in the Universities; and the best way to promote it would be to ensure that University teachers have leisure and opportunities for research, and that their salaries are not so low that they have to spend all their spare time in examining, if they are to earn enough to live upon. These men, however, require laboratories as well as leisure, and one of the results of this progress of Science has been to make laboratory equipment and apparatus far more costly than was the case a generation ago. Our Universities, as no one knows better than you, my Lord, suffer from an 'eternal lack of pence' and have not always at their command the funds necessary for the proper equipment of their laboratories. Money could be well spent in helping them to do this. There are other laboratories besides those at the Universities which are hampered by lack of funds. The National Physical Laboratory cannot afford to pay adequate salaries to its assistants, with the result that many highly trained men have left or are on the point of leaving to take more highly paid posts with private firms.

"The amount required to assist research in pure science is but small in comparison with that required for industrial research—the modesty of its requirements puts it in some danger of being overlooked altogether. In farming the cost of the seed is not a very considerable item in the cost of the production of crops. But pure science is the seed of applied science, and to neglect it would be on a par with the action of the farmer who spent large sums on ploughing and manuring his land and then omitted to sow the seed."

THE INDIAN PHILOSOPHICAL CONGRESS

The Eighteenth Session of the Indian Philosophical Congress was held at Lahore on the 20th, 21st, 22nd and 23rd of December, 1943. The Congress was opened by the Hon'ble Sir Manohar Lal, Finance Minister, Punjab. Professor P. N. Srinivasachari, President of the Session, delivered his address in which he surveyed the progress made in the several branches of Philosophy and indicated lines on which fresh developments could be effected with synthesis as the guiding principle. On the 22nd and 23rd the Congress sat in its different sections and papers on a variety of subjects were presented for discussion. On the 21st there was a symposium on 'Has Philosophy a Method of its Own?', and on the 23rd another on 'Is Beauty Subjective or Objective?' Each day of the Session concluded with a public lecture. Professor A. R. Wadia spoke on "Sociology as Applied Philosophy", Kwaja Abdul Hamid on 'Iqbal—or the Ego as a Creative Being', Prof. P. N. Srinivasachari on "The Soul of India" and Dr. B. L. Atreya on "Psychological Research and its Bearing on Philosophy."

At the General Body Meeting held on 23rd December with Rajasevasakta A. R. Wadia in the chair, resolutions were passed recording the deep sorrow of the Congress at the premature demise of Mr. S. S. Suryanarayana Sastri who had been the secretary of the Congress for several years, and of Mr K. R. Sreenivasa Iyengar who had also rendered distinguished services to the Congress. It was further resolved to perpetuate the memory of the late Mr S. S. Suryanarayana Sastri by the institution of a prize which will be awarded every year for the best essay on a prescribed philosophical subject written by a student of philosophy of an Indian University. The Executive Committee has been authorized to take steps towards collecting donations for this purpose

from the members of the Indian Philosophical Congress and other friends and admirers of the late Mr Sastri.

POST-WAR FOREST PLAN FOR INDIA

A post-war plan for forestry aiming at increasing the area under forest to about 20 to 25 per cent of land in each Province and State is suggested in a note prepared by Sir Herbert Howard, Inspector General of Forests, for the consideration of the Reconstruction Committee on Agriculture, Forestry and Fisheries. This percentage of forest land is commended as appropriate in the interests of proper land management to control floods and erosion and to secure a very desirable measure of afforestation of the dry belt in the west. Secondly, this would provide the necessary timber and fuel for the ordinary agricultural village consumer both to supply his direct wants in the matter of small timber and at the same time to release cowdung for manure.

Sir Herbert emphasizes the importance of the provision of timber and fuel for the village consumer. At present, he says, there are numerous areas devoid of forest where the wants of the ordinary agricultural villager remain entirely or almost entirely unfulfilled. The plan visualizes the creation of another 100,000 square miles of forests in British India. At present only 106,000 square miles of land is dedicated to forests which represent something like 13 per cent of the total area of British India.

Even in Provinces where the problem of supplying the agricultural village consumer with his timber and fuel is most acute, it is stated that there are great possibilities of increasing the area under forests to supply these particular wants. Also that area may be properly distributed throughout the province so that every agricultural village has its neighbouring minor forest. These minor forests would be under quite short rotations of 15 to 20 years and the first return of fuel should come from thinnings within five years of formation. At present in the Provinces of Northern India the forests generally occupy only a narrow strip along the Himalayas.

One of the chief reasons for the destruction of forests over large portions of India and the prevention of re-afforestation and regeneration, Sir Herbert Howard says, is the excessive grazing which takes place over such large areas. Grazing, he suggests, must be regulated while the tree crops are being established. If grazing is regulated, the areas will give a far greater weight of grass in a few years than they ever produced while being continually grazed.

Sir Herbert endorses the existing forest policy that areas necessary for the preservation of the general climatic and physical conditions of the country must be kept as forest and that the minimum amount of forest necessary for the general well-being of the country must be preserved or created. He suggests that the working plan position should be examined immediately after the war and steps taken to rectify over-felling which, though not excessive as a total, has been sufficiently concentrated to upset existing plans of management. In some Provinces fresh working plans can be made immediately, whereas in others it may be necessary to start with rough working schemes to be converted into proper working plans at leisure.

Proper classification of the land is recommended and it is stated that a very large proportion of the problem in India is afforestation where possible and proper control of grazing where afforestation is impossible. Proper control of grazing will make afforestation unnecessary over large areas where control alone will allow nature to re-establish forest.

It is recommended that the problem of floods, erosion and desiccation should be dealt with together under the Forest Department in close liaison with agricultural and irrigation officers. A small Reconstruction Forest Policy Committee should be set up in each Province to draw up their own programme. Heads of these Committees should meet together so that common problems can be discussed and brought into a similar plan for each province.

The note also deals with the organization of Forest Research and the future of Forest Education.

CENTRAL SERICULTURAL RESEARCH STATION IN INDIA

The Central Sericultural Research Station, long under contemplation, has now been established for the benefit of the Sericultural Industry in India as a whole, with the main station located at Berhampore and the sub-station at Kalimpong, both in Bengal. In general, its function will be the improvement and development of all stages of the industry up to cocoon production, and with this end in view the following research programme has been provisionally laid down:—

(A) *Mulberry*.

(1) Collection of all varieties of mulberry found in India as well as varieties from foreign countries and growing them side by side for the purpose of comparative study.

(2) Botanical classification of the varieties into well-defined types.

(3) Study of the various types regarding—

(i) Growth in relation to soil and climate,

(ii) Budding season,

(iii) Leaf yield,

(iv) Food value of leaf for the silk worm,

(v) Response to manures,

(vi) Susceptibility and resistance to diseases and pests,

(vii) Suitability for use as stock or scion in grafting.

(4) Trial of types considered suitable in the hills and the plains as well as in the different sericultural areas in India.

(5) Supply of parent stock to the various Sericultural Departments all over India with a view to helping them to arrange for local production on a scale sufficient to meet their own demands.

(B) *Silk Worms.*

(1) Trial and selection of univoltine races of worms collected from different countries with a view to obtaining races suitable for being reared in Kashmir, Jammu, the Punjab, Kalimpong, Khasi Hills and similar hilly regions elsewhere.

(2) Trial and selection of univoltine races suitable for use in production of first generation crosses as at present practised in Madras and Mysore.

(3) Production of improved fixed multivoltine races through hybridization (such as the Nistid and Nismo races successfully produced and established in Bengal) and further improvement of such races through infusion of more univoltine blood.

(4) Maintenance of the races obtained as a result of work under (1), (2) and (3) above.

(5) Supply of parent stocks of worms to different Sericultural Departments in India. (Thereafter it will be their responsibility to multiply the stocks and arrange for production of seed on a scale sufficient for supplying the local rearers).

(C) *Rearing of Silk Worm.*

( ) Investigation of response to different types of mulberry used as food.

(2) Investigation of response to different climatic conditions in the hills and plains.

(3) Trials to determine how more than one crop of univoltine cocoons can be reared during the year in places like Kashmir, Kalimpong, Khasi Hills, etc., as has been done in Japan.

(4) Study of the relationship of the deficiency in food value of the leaf with diseases of silk worms.

(5) Study of conditions which contribute to or prevent the occurrence of diseases in worms under rearing.

(6) Production of cocoons with large silk content and highest reeling property without loss of worms through diseases brought about by physiological derangements owing to climatic influences or defects and deficiencies of food or through diseases caused by infection and parasites.

Furthermore, facilities have been provided for training a few science graduates in higher sericulture. They will have an opportunity of practical acquaintance with all operations in the silk industry subsequent to cocoon production, *viz.*, reeling, testing of raw silk and silk fabric manufacturing processes in the various filatures in the District, at the Peddie Silk Reeling Institute, Malda, at the Silk Conditioning House at Calcutta, and in the Bengal Silk Technological Institute.

ANNOUNCEMENT

We are glad to inform that Mr. Alamohan Dass has become a Patron of the Association by donating a sum of Rs. 1,000/- to the funds of the Association.

Further, our thanks are due to the reputed firm of Messrs H. Datta & Sons Ltd. who have kindly consented to become a Patron of the Association and have already placed at our disposal a sum of Rs. 500/-, being a part of their contribution.

ACKNOWLEDGMENT

We acknowledge with thanks the receipt of the following:—

JOURNALS

(*Foreign*)

1. Agricultural Gazette of the New South Wales, Vol. LV, Pt. 2, Feb., 1944. *2.* Beama Journal, Jan., Feb., March, 1944. *3.* Bulletin of the American Meteorological Society, Vol. 24, No. 9, 10, Vol. 25, No. 1. *4.* American Journal of Science, March, 1944. *5.* Chemical Age, Vol. L, Nos. 1282, 1285-86, 1289-90. *6.* Journal of Chemical Education, Feb. and March, 1944. *7.* Journal of the American Chemical Society, February and March, 1944. *8.* Meccano Magazine, Feb., 1944. *9.* Science, Vol. 99,

Nos. 2565-68. *10*. Science & Society, Vol. 8, No. 1. *11*. School Science Review, Feb., 1944. *12*. Science News Letter, Nov., 13, 20, Dec., 25, 1943, Jan., 1, 8, 15, 22, 29, Feb., 12, 19, 26, Mar., 4, 18, 1944. *13*. Sky and Telescope, Dec., 43, Jan., Feb., Mar., 1944. *14*. Technology Review, March, 1944. *15*. Scientific American, Jan., Mar., April, 1944. *16*. Scientific Monthly, Jan., Feb., Mar., 1944.

(*Indian*)

1. Aryan Path, March, April, 1944. *2*. Brahma Vidya, Vol. 8, pt. 1. *3*. Bulletin of the Indian Central Jute Committee, Vol. 6, No. 6, 12, Vol. 7 No. 1., *4*. Current Science, March, April, 1944. *5*. Education, April, May, 1944. *6*. Hindoosthan Quarterly Journal, Vol. 1, No. 1. *7*. Indian Information. *8*. Indian Listener. *9*. Indian Journal of Agricultural Science, Aug., 1943. *10*. Indian Physician, Vol. 3, No. 4. *11*. Indian Medical Gazette, April, 1944. *12*. Indian Medical Association Journal, February, and April, 1944. *13*. Orient Illustrated Weekly. *14*. Prabuddha Bharat, April, May, 1944. *15*. Sankhya, Vol. 6, Pt. 4, Feb., 1944. *16*. Soviet Union News, April, 1944.

BOOKS

1. A Hand Book for the Identification of Insects of Medical Importance,—John Smart. *2*. British Contributions to Indian Studies—Sir Atul Chatterjee and Sir Richard Brown. *3*. Experiment and Theory in Physics—Max Born. *4*. Intermediate Practical Physics—D. B. Sinha. *5*. Land and Its Problems—Sudhir Sen. *6*. Plant Viruses and Virus Disease—F. C. Bawden. *7*. Soviet Russia—K. S. Herlikar. *8*. The Development of William Butler Yeats –V. K. Narayanamenon. *9*. The Life of Childhood – Michael Fordham. *10*. The Loom of Language—Frederic Bodmer. *11*. Rabindranath Tagore on Rural Reconstruction—Sudhir Sen.

SCIENCE IN INDUSTRY

PLASTICS TO REPLACE RUBBER

CLAYTON F. RUEBENSAAL and Earl H. Sorg, of the Martin Plastics Research Laboratory, have developed, according to a report of the *Scientific American*, February 1944, a new elasto-plastic, known as Marvinol. The new plastic, though neither a synthetic rubber nor a rubber substitute, bids fair to replace rubber in the manufacture of several products in which rubber is at present exclusively used. It has already proved superior to rubber, both natural and synthetic, for the manufacture of automobile inner tubes, elastic gloves for home, hospital, and laboratory use, and many general and industrial uses.

Marvinol is a vinyl-type plastic. It has almost all the important properties of a plastic, such as its thermo-plastic nature, superior abrasion resistance, and ability to withstand constant flexing without fatigue and impermeability to gases and liquids. Furthermore, unlike common vinyl plastics, Marvinol is stable in the presence of strong sun-light and at high temperatures and is unaffected by dilute acid or alkaline solutions. This stability at high temperatures and in the presence of acid and alkaline solutions has been made possible through the use of a non-extractable plasticizer in the compound. In fact, this plasticizer has enabled the new plastic to retain its elasticity, resiliency and flexibility, properties for which its use in place of rubber has now been so eagerly suggested. Marvinol has an important advantage over rubber in that it has no tendency to oxidize or age, and that cent per cent of the material is reclaimable.

The usual standard rubber working machinery can be employed to process the new material. Marvinol stocks can be compounded and mixed on regular open rubber mills, and extruded, moulded and calendered on the same machines as are used in dealing with rubber. The operation of vulcanization is, however, completely done away with in using the new plastic for the manufacture of rubber-like goods.

Marvinol has not only proved a better material to manufacture rubber-like goods with, but has successfully bridged many gaps hitherto not filled by synthetic rubbers. The product has proved specially successful in the manufacture of inner tubes, gloves for surgical, laboratory and household use and a number of articles for air-craft use. Nipples for nursing bottles, moulded goods, fountain pen sacks which ink will not stain or adhere to, bulbs for eye-droppers, hot water bottles, soles, heels, and pencil erasers are also reported to be made of Marvinol.

Meanwhile, Resistoflex Corporation, according to the same paper, has developed another synthetic plastic which is destined to be of great use in the air-craft industry. The air-craft industry is now greatly in need of a suitable flexible material which can handle aviation fuels, such as toluol, xylol and benzol. The failure of rubber to handle these aviation fuels has led to the development of a series of 'campar' plastics which have been described as 'transparent, flexible, rubber-like plastic materials, 5 to 20 times more wear-resistant than natural rubber, and the most solvent-proof rubber substitute yet developed'.

SOYABEAN FIBRE PLANT

ONLY a few months ago production of fibre from soyabean was no more than a laboratory curiosity. The erection of the first soyabean fibre plant at Cincinnati by the Drackett Co., as reported in *Chemical and Engineering News*, is a clear indication that the method of making fibre from soyabean has passed the laboratory stage and lent itself to production on a commercial scale.

The process involved in the production of soyabean fibre may be briefly stated. Soyabean oil is first extracted from soyabean by a method developed several years ago, leaving the soyabean meal which is largely used for livestock feed. This meal contains as much as 50 per cent protein. Required amounts of protein are then extracted from the meal to give a powder-like product which is liquified and converted into a mass of the consistency of molasses. The liquid is subjected to a great pressure and made to pass through very fine platinum spinnerets to emerge in the form of hundreds of thin filaments. These filaments are then chemically treated and at the same time stretched and hardened. Finally the fibres are dried and cut into desired lengths.

The soyabean fibre thus prepared is reported to be resilient, strong, durable and as warm as wool. It can be made either moisture-absorbent or moisture-resistant. The fibre may be used singly to be woven or spun into fabrics or may be blended with cotton or wool. Blankets, felt hats, underwear, hosiery, suitings and upholstery fabrics have already been made of soyabean fibre with success. Conspicuous as these initial successes are, further technical study of this new fibre and of new and more efficient manufacturing processes as well as of potential new uses is necessary and is in progress.

TITANIUM

UNTIL recently titanium used to be listed among the unimportant and least useful elements. In an all-out drive for the fullest utilization of world's mineral resources, rare and unimportant elements of yesterday are becoming indispensable today. Such has happened in the case of titanium whose increasing uses in peace as well as in war have brought this so-called rare element to the lime-light. In an article in *Discovery*, December 1943, Dr J. Chatt has summarized the various uses to which the metal has been applied during recent years.

Though often referred to as a rare element, perhaps because of its rare uses, titanium is, in fact, one of the commonest and most abundant of elements constituting the earth's crust. The available supply of titanium far exceeds that of sulphur, carbon and chlorine and is about four times as great as the world's combined supply of chromium, copper, lead, manganese, mercury, nickel, tin and zinc. As a matter of fact, next to aluminium and iron it is the most abundant metal known. The metal is distributed in several parts of the world in the form of ores, of which the most important are ilmenite (ferrous titanate) and rutile (titanium oxide). But large quantities of ores rich in titanium are rarely to be met with. India (Travancore) occupies the leading position among the titanium producing countries which include Norway, Sweden, Portugal, Canada, South Australia, Malaya, Senegal, Brazil, U. S. A., and U. S. S. R.. World production of titanium, excluding U. S. A. and U. S. S. R. which have not published production figures, amounted to 43,600 tons in 1931 and 264,000 tons in 1937, indicating the growing importance of the metal. In 1938, Travancore alone produced 252,220 tons.

Titanium as a metal is not so valuable. But it forms important alloys with iron, aluminium and other metals. Alloyed with titanium steel develops great strength and resistance to abrasion. The great affinity of titanium for nitrogen and oxygen is often utilized in removing these harmful impurities from molten steel. All aluminium alloys are said to be improved by small amounts of titanium. Titanium dioxide is the most important of titanium compounds and has received several important applications. Rutile, the naturally occurring dioxide, is employed in electric welding. The pure dioxide obtained from ilmenite is used as a pigment, known as titanium white, and also in paints, enamels, lacquers, and glazes. It has better covering capacity which exceeds that of white lead, and is further non-poisonous and, unlike white lead, not blackened by traces of hydrogen sulphide in air. The high refractive index of titanium dioxide has recommended its use in paper making to prevent printer's ink showing through. In small amounts, it is used in rayon, rubber, linoleum, plastics, leather, soap, face powders, face creams, tooth pastes, etc., where opacity is required to be developed.

Titanium dioxide has a high dielectric constant with the advantage of low dielectric loss. It has already been used in the manufacture of insulators, and particular mention may be made of magnesium titanate which is now employed as the dielectric in high frequency condensers.

Other titanium compounds have also formed useful applications in textile and leather industries. The compounds are used as mordants for dying fabrics. Potassium titanium oxalate stains leather to various shades of brown and produces a less brittle product than when iron salts are used. The ability of titanium tetrachloride, a strongly fuming liquid, to produce dense smoke screens has made it an important war chemical. It is reported that in 1918, in connection with the last Great War, 160 tons of titanium were alone used for the production of titanium tetrachloride.

If titanium is little known today despite its various and growing uses, it is because none of its uses has so far proved spectacular enough to attract widespread attention.

RISE AND DECAY OF THE INDIGO INDUSTRY IN INDIA

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(Continued from the last issue)

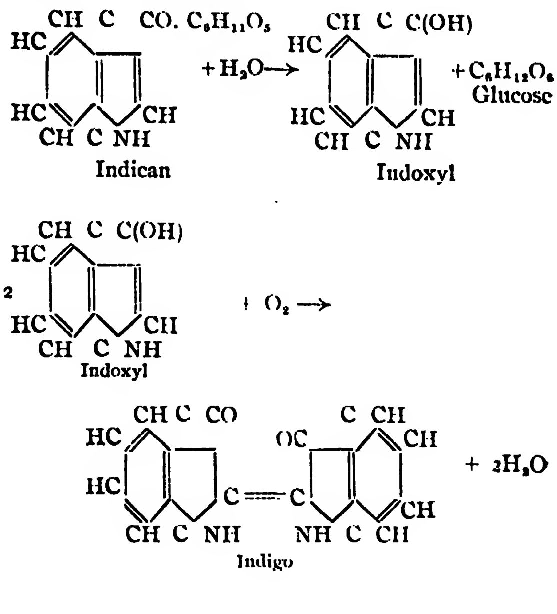
Extraction of Indigo—Dry Process

In Madras the dry leaf process of indigo manufacture is still pursued to a limited extent. During the first century of the industry as fostered by the East India Company, the dry process was universally adopted. It was even upheld that to that fact was attributable the high merit of the Indian as compared with other indigoes. During the second century, when the industry had been carried from the West Indies back to India (Bengal), the wet process alone was employed.

In the dry method the bundles of freshly cut plants are dried and the leaves separated from the stem by beating. When kept dry the leaves undergo a great change in the course of a few weeks, their green tint turning into a pale blue-grey colour. They are then subjected to steeping and fermentation and allowed to macerate for 2 hours when the *indican* present in the plant splits through hydrolysis into ***indigotin*** and ***indiglucin***. The fine green liquor is then drawn off into the beating vat, when the matured indigo is precipitated and subsequently concentrated by boiling and compressed into cakes and dried in the usual way. Dry system of indigo manufacture have distinct advantages. For a small manufacturer it has great advantage of being attended to at the most convenient time and the indigo may be more uniformly made. Moreover the fermentation process in the case of fresh leaves is here superseded by a much shorter period of simple maceration (Watt 1908).

Chemistry of Indigo

Indican occurring in the leaves, when hydrolysed yields glucose and indoxyl. The latter is oxidised to indigo (See p. 493). The equation representing the reaction is as follows:—

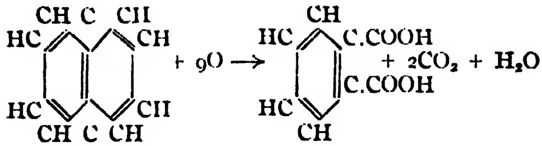


Synthetic Indigo

The method that has proved a commercial success has at its starting point a reaction discovered by Heumann in 1890. (See p. 490).

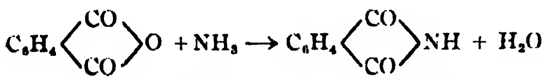
The starting material in Heumann's synthesis of indigo is naphthalene ($C_{10}H_8$). This is first converted into phthalic acid by oxidation with sulphuric acid in

the presence of mercuric sulphate which acts as a catalyser:



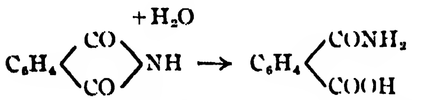
Naphthalene Phthalic Acid

The anhydride of this acid, when heated in a current of dry ammonia yields phthalimide:

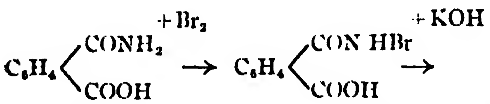


Phthalic anhydride Phthalimide

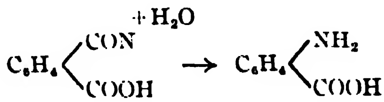
Phthalimide is then warmed with bromine and potassium hydroxide. The alkali hydrolyses the phthalimide, yielding phthalaminic acid, which subsequently by the action of bromine and potassium hydroxide is converted into anthranilic acid.



Phthalimide Phthalaminic acid



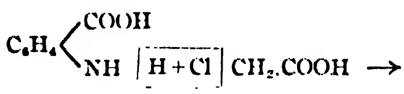
Phthalaminic acid Intermediate products



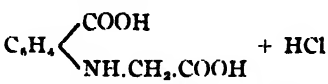
Anthranilic acid

The anthranilic acid is treated with chloroacetic acid to obtain phenyl-glycine-o-carboxylic acid.

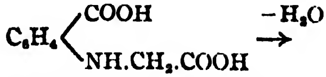
This acid when fused with caustic potash yields indoxyl, indoxylic acid being formed as the intermediate product.



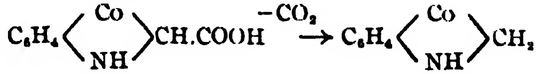
Anthranilic acid Chloroacetic acid



Phenylglycine-o-Carboxylic acid



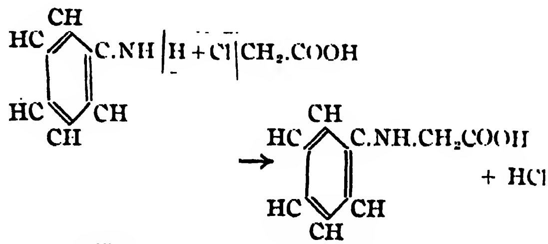
Phenylglycine-o-Carboxylic acid



Indoxylic acid Indoxyl

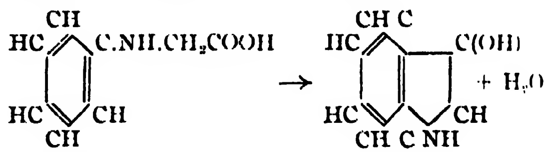
The fused mass, containing indoxyl, is dissolved in water and a stream of air is passed through the alkaline liquid, when indigo-blue is precipitated (Compare preparation of natural indigo).

Another synthesis carried out on a larger scale is as follows: Aniline is treated with monochloroacetic acid when phenyl-glycine is obtained.



Aniline Phenylglycine

Phenyl-glycine is fused with sodamide at 180° to 240° when indoxyl is produced, which may be converted into indigo-blue as in the above synthesis.



Phenylglycine Indoxyl

$$NaNH_2 + H_2O \longrightarrow NH_3 + NaOH$$

Sodamide

Artificial *versus* Natural Dyes

When the colouring matter was derived chiefly from vegetable sources, the processes were lengthy and laborious and the results uncertain; the use of imported synthetic dyes equally shortened and simplified operation and gave more certain results, thus enormously reducing the cost.

Attempts made since the last Great War to replace the synthetic dyes have apparently established the fact that vegetable dye-stuffs are incapable of meeting the demands of the industry on its present scale, and the change in taste brought about by the ***brighter synthetic dyes*** renders it difficult to find a market for the ***thinner and duller*** though perhaps

more pleasing colours of vegetable origin. The quality of synthetic dye is inferior and the price is abnormally low but it is easier to handle and apply and is used for poorer grades of cloth, when permanency is not essential.

Natural indigo as extracted by the wet process consists of blue lump containing 60 to 80 per cent of indigo blue or indigotin and small quantities of other colouring matters, such as *indigo red, indigo brown, indigo green,* 'indigo gelatin' and ash. These are to be regarded as impurities and may be removed by successive treatment with water, dilute acetic acid, caustic soda and alcohol.

The artificial indigo of commerce manufactured in the Badische Aniline Factory in Germany is almost pure indigotin containing no indigo red, indigo brown or indigo green, which is also a disadvantage as these substances have some beneficial effects in dyeing. For silk, the natural indigo still produces better results than the synthetic substitute. But owing to better business methods, the synthetic product enjoyed a rapidly expanding market driving natural indigo from the places where it was least remunerative.

One of the principal disadvantages under which natural indigo has to compete with the synthetic product is that the former is in the form of dry cakes which have to be converted into paste before being used for dyeing purposes, while the latter is sold as readily available paste. (Banerjee 1896 ; Watson 1907)

Causes of Indigo Crisis

The crisis in the indigo trade has thus been brought about in various ways : —

(1) The quarrel between indigo planters and raiyats on the one hand and Zamindars on the other.

(2) The extension of indigo cultivation in the U. P., the Punjab and in Madras and the consequent competition which reduced the price to the lowest level.

(3) The manufacture of the dye by a synthetic process in Germany.

With regard to the unwillingness of cultivators to grow indigo, it is to be noted that the growing of the crop instead of impoverishing their land actually made it better suited for the growing of cereals and if indigo is cultivated on one-fourth or one-sixth of the cultivators' land in rotation, it would be of mutual advantage to the planter and the cultivator. Further, indigo refuse is the manure most easily obtained and is very valuable as one of the best fertilisers. It is less suited for indigo itself, than for rotation crops such as sugarcane, tobacco, poppy, cereals and oil seeds. Indigo plants forced by indigo manure to very active growth gives a poor percentage of dye matter and is liable to injury from insect pests. (Mukherji 1923).

Suggestion for the improvement of indigo industry, to effect a reduction in the cost price of indigo and thereby secure a profit to growers and manufacturers have been put forward from time to time since the discovery of the synthetic dye.

Sir Edward Law's Recommendations

Sir Edward Law (formerly Finance Member to the Government of India) in 1905, in view of the unfortunate falling off of the production of indigo suggested as follows : —

(1) That the plantations should be placed on a sound financial basis, and cease to remain in a position where requirements for cash in seasons of dear money could only be satisfied by transfering profits from the pockets of the planters to those of the money-lenders, (2) Economy in management, (3) Selection of seed and propagation of the qualities yielding the highest per cent of indigotin and best suited to local conditions of climate and soil, (4) Rotation of crops to obtain good profits from the land when not under indigo and thereby reduce the cost of cultivation of the plant, and (5) Chemical improvements in manufacture.

Sir George Watt observed "There would seem no doubt that each one of the conditions of improvement indicated by Sir Edward are of vital importance and what is sure to the point, hardly any of them, have been successfully and completely investigated." (Watt 1908).

Not much satisfactory progress however followed the recommendations of Sir Edward and the indigo trade gradually declined as already explained before, till we come to the period of the last Great War.

Indian Industrial Commission's Recommendations

The Indian Industrial Commission, with Sir Thomas Holland, F.R.S., as its President, was appointed by the Government of India in 1916. The commission was instructed "to examine and report upon the possibilities of further industrial development in India", and they submitted in 1918, the following ways, neglected in the past, that offer prospects of success with regard to the indigo industry in the future : —

(1) *The Application of Scientific Agriculture.*— (*a*) the adoption of phosphatic fertilisers and other improved methods of soil treatment, (*b*) the breeding of plant varieties able to withstand the wilt disease, (*c*) the organisation of seed farms under suitable

climatic conditions outside indigo growing districts. (*d*) the rotation of indigo with other crops of marketable value.

(2) *The Process of Manufacture.*—(*a*) the recent recognition of the fact that the precipitation of indigo is essentially due to a ferment, the cultivation of which under suitable conditions may permit of a great increase in yield, (*b*) the preparation of a standardised product for the market.

(3) *The provision of improved financial facilities.* Evidence put before the Commission in Bihar, left the impression that natural indigo, if cultivated and manufactured on scientific lines, offers prospects of great improvement, probably sufficient to enable it to hold its own in competition with synthetic indigo.

It was further observed "By careful management under favourable financial conditions several planters have prospered, in spite of the absence hitherto of the advantages which the application of scientific agriculture might bring them and, though it is impossible to estimate the prices at which synthetic indigo will be placed with profit in future markets, there is no doubt that the prospects before the natural product are sufficient to justify experimental work and enterprise in organisation along the lines indicated above." (Govt. publn. 1918).

Indigo Cess

"In 1918, by an act of the Imperial legislature an indigo cess was imposed at the rate of one rupee per bazar maund (of $82\frac{2}{7}$ lbs. avoirdupois) on all Indian indigo exported, the proceeds of the duty to be expended by the Government of India, for scientific research work in connection with the cultivation and manufacture of indigo, a corresponding cess being imposed on all exports from Travancore to ports outside British India or to Aden. The rate of cess was changed to Rs. 1/8/- per cwt. of 112 lbs. avoirdupois with effect from April 1, 1921."

Since 1860, there was a general export duty of 3 per cent *ad valorem* but the duty on indigo was remitted in 1880.

"Investigations were conducted at the Pusa Research Institute by the Indigo Research Chemist to the Government of India but it was terminated and the cess abolished with effect from 1st August, 1923. In 1922-23 the cess yielded £533, and in the four months from April to July, 1923, £212 only. At one time it was anticipated that the expenses of the London Indigo Committee will also be met from the proceeds of this cess". (Saksena, 1937).

Recommendations of Davis and Reid

Davis, the Indigo Research Chemist to the Government of India, while reviewing the position and future prospects of the natural indigo industry (1918) remarked "that very great improvements can be made" and "that the future of natural indigo is by no means a hopeless one provided steps are taken to realise such improvements as are clearly possible." The fate of natural indigo will be determined by several factors each of which has its own special importance. (Davis 1918). These are:

(*a*) Improvement in Agriculture, (*b*) Improvements in methods of marketing the product, (*c*) Improvements in actual manufacture, either by chemical or bacterial means, (*d*) Improvements by botanical selection, (*e*) Improvements in business organisation.

Reid in a paper on the "Ten years practical experience of Java indigo in Bihar" (1917) indicated the lines on which research work would appear to give the best results.

(*a*) The first and most important point is a supply of pure seed. If a full supply of seed was obtainable and the sowing rate increased, the result on the return of finished indigo would be very marked. To grow Java indigo for seed would never give best results in Bihar, for the following reasons:—

(*i*) the country is subjected to periodical flooding at the time when the seed plant must be in the ground.

(*ii*) It is very doubtful whether any remedy will be found for diseases such as 'wilt' and 'Psylla'.

It was suggested that if a regular and full supply of Java seed is to be secured some other locality would have to be discovered for seed growing.

(*b*) the second line of research appears to be increasing the wilt resistance power of the plant by selection and after that is obtained,

(*c*) research should be directed to improving the indican content of the leaf (Reid, 1917).

The seed problem was acute in 1913 and the industry was in danger of extinction from this cause alone. The supplies had fallen low and insufficient for sowing while the price had reached a point which seriously reduced the margin of profit.

According to Howard (1920) the solution of the problem of seed production was found to be in the growing of a special seed crop and in obtaining the seed from most vigorous plants.

Research Work on Indigo

A large amount of attention has been devoted in the past, both by Government and by the planters, to the improvement of the indigo industry in Bihar. Investigations have been in progress since 1898 with the object of increasing the yield of indigo per acre and thereby assisting the industry to meet the com-

petition of synthetic product. Rawson, Bergthiel, Bloxam, Leake and Parnell carried on their investigations at Sirsiah Experimental Station which was closed in March, 1913.

Bihar Planters' Association wisely decided to close the station and asked the Imperial Government to continue the work which was transferred to the Botanical Section of the Pusa Institute.

From the beginning of 1898 to the end of 1913 the sum of £54,207 was expended on indigo research work in Bihar. Of this large sum £32,052 was contributed by Government and the remaining £22,155 by the Bihar Planters' Association.*

Earlier workers dealt exclusively with the chemistry of the manufacturing process, and some botanical aspect. Very little work was done on purely agricultural side and on the physiological aspect of the role of indigo-producing principle in the plant. (Howard, and Howard 1914).

Localisation of Indigo Producing Substances

Leake (1905) commenced research into the species of the plant grown and the localisation of the dye within the plant tissues, but his studies were brought to a sudden end by the severance of his connection with the Planters' Association. Bloxam attained some progress in his chemical studies of the dyes.

Parnell (1915) worked on the physiology of indigo yielding glucosides *i.e.*, with the biology of indicans in particular and glucosides in general. In *Indigofera sp.* the glucoside is practically confined to the leaf and youngest parts of the stem though a small amount varying in different species occurs in some of the reproductive organs. In *I. arrecta* the maximum per cent content occurs at a very early stage in the development of the leaf. The actual amount in any leaf increases during growth to a maximum at maturity and remains constant till leaf falls when the whole is present in the fallen leaf. In the light of present knowledge no definite function can be assigned to indigo-yielding glucosides in the plant and indican seems to be a bye-product of the plant's metabolism (Parnell, 1915).

Deficiency of Phosphates of Bihar Soil

As early as 1902 Rawson pointed out in his report on indigo that Bihar soils were decidedly deficient in available phosphate and in 1907 Dr Leather made a series of analysis of soil from indigo areas in Bihar. In a report to the Bihar Planters' Association (1908) Leather states "The chemical analysis of the soil showed them to be almost uniformly deficient in available phosphate".

In spite of this warning, phosphate manuring has been used only in isolated cases and the neglect of this has been the main cause of certain difficulties in indigo cultivation and the undoubted falling off in later years.

Davis (1917) in a report to the Government on the indigo industry of Bihar reiterated this abnormal deficiency in phosphate of the soils of Bihar and its effect upon the growth (quality and yield) of indigo.

Howard (1920) however, did not support the view that manuring with superphosphates will increase the growth of Java indigo. On the other hand the growth of indigo crop depends mainly on (1) soil aeration and (2) organic matter.

Howard further, contrary to our previous ideas, observed that Java indigo seriously depletes the supply of soil nitrogen and behaves very much like a cereal. The soil loses more nitrogen than it gains. Intense colloidal condition of the soil often prevents percolation altogether. The pore spaces become water logged for long periods and a condition is established which profoundly affects both the bacteriology and the chemistry of the soil and the plant reacts immediately. At first there is a cessation of root action, followed sometimes by the destruction of the absorbing system except or near the surface. In Java indigo, the establishment of colloidal condition was eventually followed by the general wilting of the crop. (Howard and Howard 1927).

The cultivation of Java indigo in Bihar fell from 10,000 to 15,000 bighas between 1910 and 1914 largely on account of the wilt disease and the difficulty of obtaining seed. Investigations on the causes of indigo wilt and its prevention was carried out by Howard (1915-1921).

Java indigo introduced into Bihar from Java in 1898, at first did exceedingly well, yielding heavy crops of leaf rich in indican as well as abundant seed. After some years, however, the plant began to show increasing signs of want of vigour and finally began to die of wilt during the second half of the rainy season. At the same time, the yield of seed diminished. The degeneration was progressive and by 1913 many planters had already abandoned the cultivation.

Indigo wilt and its Cause

Wilt appeared after the first cut during July and August, the severity of attack depending on the season. The plants die off in stages, the process taking place slowly. Neither insect, fungi or bacteria have been found to be responsible for the trouble. Howard's investigations indicate that wilt results from the destruction of the fine roots and nodules under circumstances when regeneration is impossible. When the roots and nodules of an indigo plant have suffered extensive damage wilt invariably results from any cause which interferes with normal root regeneration. The chief source of damage to the active roots and nodules arises from the complete cutting back of

* Badische Aniline und Soda Fabrik Company spent a sum of £900,000, exclusively for research work in connection with the manufacture of synthetic indigo. (Chakravorty, 1944).

the plant. This results in the destruction of practically all the fine roots and nodules and root regeneration is necessary before new growth can take place. Root regeneration becomes difficult due to poor soil aeration, due to lack of sufficient reserve material in the tap root and due to too low soil temperature and wilt follows. (Howard, 1920, 1924).

Selection Work

The details relating to the flowering, pollination and occurrence of natural cross-fertilisation in Java indigo and bearing of these facts on the improvement of the crop was also dealt with to a considerable extent by Howard.

The crop is composed of a mass of heterozygotes, differing widely in habit, time of flowering, root range, and amount of leaf surface. There is a great falling-off in vigour observable in the plants raised from self-fertilised seed. These circumstances and the ease with which the land becomes contaminated with the seed of previous culture, render the improvement of Java indigo by the methods of pure line selection a time-consuming and a very difficult undertaking.

Attempts to cross Java and Sumatrana indigo at Pusa failed. On several occasions plots of these two crops have been allowed to flower side by side in October and November but no natural crosses have been observed in succeeding generations.

The progressive degeneration of the indigo crop has been found to be due to a gradual change in the gametic constitution of the crop, which has been in progress since Java indigo was first introduced in Bihar.

All the species of indigo examined at Pusa rarely set seed under net. In a single generation from self-fertilised seed there is a marked falling off in the size and vigour of the offspring, so that both self-fertility and natural cross-fertility have to be considered in any improvement by selection.

The stoppage of selection, the mixing of kinds which is a characteristic of Indian agriculture and the resulting crossing with types which do not suit Bihar completely altered the botanical composition of the crop and rendered it unsuitable for growth under monsoon conditions. (Howard, 1919).

When the Bihar Planter's Association lost their interest in indigo plantations, the few remaining firms formed the Indian Indigo Association in 1920, to look to their own interest. Since the abolition of the indigo cess in 1923, there was an unspent balance of Rs. 1,500/- in the fund in 1925, which was available for expenditure on problems connected with the improvement of indigo. The amount was handed over to this association for meeting the cost of London experiments on research for a dyeing process of natural indigo which would be shorter and less complicated than the existing process (Report of the Indigo Association, 1926).

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MEDICINE AND PUBLIC HEALTH

OX BLOOD FOR BLOOD TRANSFUSION

The possibility of using bovine plasma in human beings in states of shock, hypoprobinaemia and protein deprivation and loss, calling for blood tranfusion, has been recently demonstrated by Dr Edwards and his collaborators in a series of experiments (*Brit. Med. Jour.*, January 15, 1944 ; also for a shorter report see *Nature*, January 29, 1944). Increasing pressure in blood banks and their limited supply have led to a number of substitutes for human plasma. But such substitutes do not satisfy all the three requirements essential for successful blood transfusion. These three requirements are: (1) it should be retained in the circulation and eventually be metabolized, (2) it should exert an osmotic pressure same as that of the plasma and (3) it should be non-toxic, free from anti-bodies and non-antigenic. Although bovine blood has some commendable characteristics, it is not without difficulties. The satisfactory fact about bovine blood is that its total protein most nearly approaches that of human plasma. But it contains a much higher percentage of fibrinogen, and its albumin-globulin ratio is lower, resulting in a lower osmotic pressure of bovine blood. These considerations make crude bovine serum unsuitable for use. In fact, the use of crude serum has been found to produce serum sickness and a tendency to haemolysis of the human red cells.

Dr Edwards and his collaborators have adopted a method of processing bovine serum which is claimed to fulfil the above requirements. The process consists in heating the serum to 72°C to destroy the anti-bodies and in adding 0·2 per cent of formalin and ammonia to render the proteins uncoaguable. The serum known as Despeciated Bovine Serum (D.B.S) has an osmotic pressure comparable to that of filtered human plasma and is well retained in the circulation. It has not developed signs of deterioration after long storage (9 months) in a refrigerator. The report of a preliminary trial on 26 patients is encouraging and recommends its safe use in human beings.

The possibility of the tuberculous infection or *Brucella abortus* of bovine serum has also been given due consideration. This can be solved on the report of the meat inspector, making it possible to discard the blood of the grossly infected animal. Furthermore, as Dr Edwards suggests, the blood may be subjected to Seitz filtration during the process of manufacture to remove any of these organisms infecting the blood.

VITAMIN SUPPLIES IN PREGNANCY AND CHILDHOOD

In his article "The Role of Vitamin Concentrates in War and in Post-war Food Relief in Europe" in *Nutrition Abstracts and Reviews*, Vol. 13, No. 1, July 1943, V. P. Sydenstricker has dealt with the vitamin requirements of pregnant women and children. The effects of malnutrition in pregnant women seem much more subtle than any symptoms or signs which can be detected clinically or any disturbance of metabolism that can be measured in the laboratory. It is only rarely that gross deficiency disease develops during pregnancy, even among the women of a chronically malnourished population. Nevertheless it has been shown that improvement of the nutritional status during pregnancy can reduce maternal morbidity and cause a marked decrease in the incidence of abortion, premature delivery and still-birth. The most striking results were obtained in the experiments performed in Toronto (1941), in which pregnant women received a liberal dietary supplement of milk, cheese, oranges and canned tomatoes and, in addition, wheat germ, vitamins B_1 and D and iron. Toxaemia occurred in only 3·5 per cent of a group of 90 women, and there were no miscarriages or stillbirths. In the control group of 120, the incidence of toxaemia was 7·6 per cent, there were 7 miscarriages and 4 stillborn infants. In the much larger group of about 3,000 primiparous women studied in London (People's League of Health, 1942), no supplement of food was furnished, but the women took liberal amounts of a preparation of B vitamins, ascorbic acid and vitamins A and D as well as iron, calcium and a mineral mixture containing iodine, manganese and copper. The incidence of toxaemia, as judged by the presence of hypertension or albuminuria, was 27·1 per cent in the treated cases as compared with 31·7 per cent in a control group of equal size. The corresponding values for incidence of prematurity were 20·1 and 23·9.

These results were obtained in times of peace when there were no restrictions on the amounts and varieties of foods obtainable except the money available for their purchase. In war, with animal protein and fats rationed and citrus fruits unavailable for adults, it would seem not only desirable but necessary to make vitamin concentrates as well as iron and calcium available to all expectant mothers. Codliver oil or other sources of vitamin A and D and synthetic ascorbic acid are particularly necessary. The use of wheatmeal bread and potatoes as chief sources of

calories makes it unlikely that supplements of the B group of vitamins are generally required.

The present status of children in Britain is probably better than that of any other group of the civilian population. The needs of small children are provided for by the universal distribution of cod liver oil and good sources of ascorbic acid in addition to milk. There may be justification for concern over the ascorbic acid intake of children of school age, particularly during the late winter and early spring. Should there be any evidence of deficiency there should be neither hesitation nor delay in making ascorbic acid universally available for as long a period as necessary. Indiscriminate dosing of children with mixed vitamin concentrates in an effort to prevent upper respiratory infections or for "tonic effect" has no experimental or clinical support (Kuttner, 1940). It may in fact do harm by exciting disgust for food.

ROLE OF VITAMINS IN BLOOD FORMATION

It is generally known that the production of blood cells requires the proper supply of iron, protein, glucose, haemoglobin, xanthopterin, excessive amounts of cobalt and the anti-pernicious anaemia factor of liver extract. There are now clear evidences that certain vitamins also play important part in the production of blood cells. *Sience News Letter*, February 12, 1944, reports that at least two vitamins of the B complex group, riboflavin and the pellagra-preventing niacin, appear to be necessary for the production and regeneration of blood. Dr C .A. Elvehjem and his associates, of the University of Wisconsin have found that dogs supplied with a synthetic diet containing all the known essential nutrients except riboflavin develop anaemia and quickly respond to a corrected diet containing adequate amounts of riboflavin. The results of these experiments therefore suggest that' riboflabin is indispensable for normal growth and development.

The requirement for niacin for the building up of blood cells has been demonstrated in dogs. Dr Philip Handler and Dr William P. Featherston, of Duke University School of Medicine, have shown that such anaemia is specially due to the deficiency of niacin and can be corrected by the administration of adequate amounts of this vitamin. They advocate that niacin is necessary for the proper production and maturation of red blood cells. This vitamin is known to play an important role in the respiration of all cells of the body. The lifetime of blood cells appears to be very short and the rate of turnover is quite rapid. Consequently the requirements of niacin for the manufacture of blood cells might be correspondingly great. A niacin deficiency, besides producing the usual symptoms of pellagra, might also lead to anaemia because of the inadequate supply of this vitamin for development of the red blood cells in the early stages.

PRACTICAL AND PUBLIC HEALTH ASPECTS OF NUTRITION

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NUTRITION AND HUMAN WELFARE

In planning a social order under which everyone will attain freedom from want, freedom from fear and freedom to attain a full life, one is faced from the outset with the question of the need for proper and adequate nutrition. The importance of food for health is now recognised by all Governments. It is no doubt somewhat difficult to assess accurately the effect of diet on health in different classes as faulty diet of the poorer classes is usually accompanied by other unfavourable conditions associated with poverty such as bad housing, an increased incidence of infectious diseases and unfavourable psychological factors. Results of feeding tests in which environmental conditions apart from food are unchanged show that improvement of the diet is followed by a striking improvement in health and also in the rate of growth of children. Some have pointed out that heredity also is another factor to be considered in relation to physique and susceptibility to certain diseases. However, in many of the investigations on the influence of heredity, the correlation found was probably more between environmental factors than inherited genes. Investigations on people belonging to the same stock but living in colonies and the mother country show that food markedly affects not only stature but bodily configuration. An increase of 2-3 inches in the average stature of children leaving school, the remarkable fall of infant mortality and tuberculosis death rates and other indications of the great improvement in health in Great Britain in the

last twenty years have been primarily due to improvements in the diet. The correlation between quality of diet and health and physique has been beautifully brought out in the famous experiments of McCarrison at Coonoor. McCarrison's results show that the marked differences in the physique of the people of the different provinces in India were due mainly to the differences in their diets.

There is no longer any doubt that faulty diet is the cause of deficiency diseases in people and of much ill health not sufficiently severe to be classed as disease. Faulty diet decreases resistance to some infections, is a predisposing cause of some chronic diseases and also causes some forms of mental depression and other abnormal psychological states. In planning for human welfare, therefore, food must be treated as the first and most important material requirement for the fuller life of the new world order.

As a result of the deliberations of various expert bodies set up by the British Medical Association (1933), by the Department of Home Economics of the United States Department of Agriculture (1933) and by the League of Nations (1935), we now possess accepted standards of dietary requirements—of requirements for calories and proteins—and general statements on mineral and vitamin requirements. The requirements of minerals and vitamins have also been placed on a quantitative basis by recent nutritional investigations in Europe, America and India. A good deal of information is available on the clinical signs of minor degrees of deficiencies and methods for assessing the state of nutrition have also been developed. Investigations carried out under the auspices of the I. R. F. A.—on protein and mineral requirements in Indians at Dacca and on vitamin requirements at Coonoor—show that these yardsticks to measure the adequacy of nutrition can also be applied to the population in India.

Morbidity and Mortality Statistics

The broad facts regarding the health and physique of people brought out from surveys of diet and state of nutrition can be obtained from morbidity and mortality statistics. As the quality of the diet deteriorates there are increases in the infant mortality and tuberculosis death rates and also in the incidence of diseases due to faulty diet. Morbidity statistics, except perhaps in the case of one or two diseases, are entirely lacking in India. The infant mortality rate for 1938 in British India as given in the Report of the Public Health Commissioner is about 170 per 1000 live births compared with 53 in England (it was 97 per 1000 live births in 1918) and 80 in Scotland. These figures point out in a most significant manner the appalling malnutrition prevalent in India. Incidently the need for improving the machinery for collecting morbidity and mortality statistics cannot be over-emphasised.

The Statistical Position with regard to Food Production

A study of the data on the food production in India is of great help in assessing the extent of undernutrition in the country. The figures are admittedly imperfect and relate to a crop year which runs from the 1st July to the 30th June next and thus neither corresponds to the calendar year nor to the financial year. Moreover, information is entirely lacking for about 47 per cent of the total area covered by the Native States and also for the Tribal Area of the North West Frontier Provinces and British Baluchistan. While area statistics are fairly reliable, the same cannot be said about the standard normal yield per acre and the condition factor, all of which together determine the figures about annual yield. In contrast with Western countries where about 30—40 per cent of the total calories yielded by ordinary diets is derived from cereals, about 90 per cent of the total calorific value of the Indian dietaries is obtained from this source. Hence in India data about production of cereal grains require close examination to determine if the food supply is adequate for the population.

The area under cereal crops in British India is, according to the latest census figures, about 147 million acres and the total area under all food crops including sugar about 215 million acres. The aggregate yield of the grains is about 55·8 million tons of which about two and a half million tons are required for seed. About 53 million tons cereals are thus available for human consumption. If the population of British India be taken as 296 millions the needs of the entire population can be met by about 60 million tons of cereals per year. British India is thus faced with an annual deficit of about 7 million tons of cereal grains. There is no doubt that children would consume less cereals but against this must be considered the wastage during processing, storage and transit and also the quantity of grains consumed by cattle and poultry. The food production data show that a considerable fraction of the population do not, even in normal times, get enough food to cover fully its calorie requirements.

The over-all deficit is not a correct index of the degree of scarcity in urban areas. Generally only the balance of what is left over after meeting the requirements of the producing rural areas goes to the urban areas and not a fixed percentage of the total production.

Considering the provinces individually, the deficit provinces are Bengal, Bombay, Madras, Bihar, Assam and North Western Frontier Provinces while

provinces producing more food than their requirements are the Panjab, United Provinces, Sind, Central Provinces and Berar, and Orissa. A close examination of the figures for the production of different cereals in the various provinces clearly shows that even with Inter-Provincial transport of food grains it will not be possible to meet the deficit of a particular grain in one province with a surplus of the same food grain from other provinces. The food problem in India is thus not merely of increasing the production of food to secure an adequate supply for the entire population but also of adjusting the food habits of people so that rice-eaters should be prepared to consume a certain amount of wheat and probably also of millets. As already mentioned the figures of food production are very rough. It is very desirable that better data should be available and periodical estimates preferably twice a year—should be drawn up showing the quantity of food produced in the country.

Results of Surveys of Diet, State of Nutrition and Incidence of Deficiency Diseases

The conclusions about under—and mal-nutrition among the people of India from production data are fully corroborated by the results of surveys of diet, state of nutrition, incidence of deficiency diseases and other investigations. About 100 diet surveys, have been carried out in various parts of India. Each of these surveys makes a quantitative investigation of all the foods consumed by a group of 15 to 30 families in a given area over a period of 10-20 days and they show what foods are consumed by a particular class of the population. A considerable margin of error is inevitable in analysing the results of dietary surveys specially regarding the intake of vitamins. Such surveys, however, are the best available means of getting information on the highly important question of the extent to which people of the different classes and in different parts of the country are undernourished or malnourished. These surveys show that 30—40 per cent of the families do not get enough food to meet the calorie requirements. The diet is also qualitatively very deficient. In addition to his staple cereal the poor Indian takes only small quantities of pulses (0·5—1·5 oz. daily) and vegetables and the consumption of milk, fish, eggs and meat is, except in certain areas, practically negligible. The intake of animal proteins is very little and the diets are usually deficient in calcium, vitamin A and carotene, and the various factors of vitamin-B_2 complex. The Indian can afford to take very little vegetable fat and negligible quantities of animal fat. These dietary deficiencies are reflected in the health of the people, in abnormal rates of infant and childhood mortality, in the height and weight of children and in the incidence of various diseases. The nutritive value of the typical Indian dietaries has also been tested by carefully controlled metabolic experiments on human subjects and the defects mentioned above have been fully corroborated.

There is also a widespread existence of food deficiency diseases which are preventable by corrections in the diet. Diseases due to deficiency of the one or other of the vitamins are night-blindness and xerophthalmia, beri-beri, angular stomatitis and rickets and osteomalcia. The anaemias specially the anaemias of pregnancy associated with malnutrition are also quite common in India. Malnutrition also decreases the resistance to diseases like tuberculosis, and leprosy which are also prevalent on a large scale in India.

Public Health Nutrition Work

Attention to proper nutrition of all classes of people should, therefore, be a prominent feature of the public health work in India. The vastness of the country and the multiplicity of problems make it desirable that there should be a common centre of guidance, inspiration and advice. The public health departments in all the provinces and States should have nutrition officers and the centre should be kept constantly in touch with the situation in the provinces and States. Morbidity and mortality figures should always be ready at hand. Surveys of diet and state of nutrition should be undertaken at regular intervals.

Education on the importance of food for health, on the relative nutritive values of different foods and on the methods of constituting balanced diets from available materials should be a prominent feature of the public health propaganda work. Lantern slide lectures and exhibitions should be arranged even in the remotest villages and also at village fairs. Poverty no doubt is the most frequent cause of inadequacy of diet but sometimes ignorance, carelessness and apathy are also responsible for faulty diet. Special attempts should be made to approach the housewife who is responsible for the preparation of the food. Appointment of lady health visitors who would do this work is an urgent necessity. The baneful effect on the future generation and on the entire family, of the mother denying herself and reserving the best of the food for the rest of the family should be pointed out to her.

Co-ordinated measures for improving nutrition

There is an enormous gap between the food supplies in the country and the physiological needs of the population. The first obvious step to be taken to remedy this state of affairs is to increase the food

supply of the country to provide sufficient energy-giving as well as protective foods for the entire population. A food policy based on human needs would have a profound effect upon agriculture and economic problem. Increments to food supply must either be grown in India or imported from abroad. Imports no doubt act as a safety-valve in years of bad harvest. Moreover, the absence of imports reacts adversely on the food situation to an extent which is out of all proportion to the actual magnitude of imports. But so long as the war lasts and for some years after it has ended, India will have to rely mainly on her own resources. After the war the world will be faced with general shortage of food and transport. A bold policy of food production is therefore, imperative. To ensure the supply of "enough food" the production of cereals has to be increased and to ensure "the right kind of food" steps have to be taken to increase the supply of milk and milk products, eggs, fish, citrous fruits and green leafy vegetables.

So far as increased production of cereals is concerned, the enormity of the problem will be realised if we consider that "an increase in the daily consumption of as little one ounce per capita would involve an addition of some 4 million tons per annum to the available food-supply" for the whole of India.

The available supplies of food can be increased by

A. Development of Agriculture,

B. Development of Animal Husbandry and Fisheries and

C. Prevention of the milling of rice to a high degree.

A. *Development of Agriculture.*

Production of food can be increased by

I. Increasing the output of the cultivated areas,

II. The utilisation of agriculturable waste lands, and

III. Replacing cash crops by food crops.

I. *Increasing the output of cultivated areas:*

The yield of crops in the cultivated lands can, according to the agricultural experts, be improved by (1) using heavy yielding and better varieties of seeds, (2) greater use of manures and fertilisers, (3) better supply of water, (4) better control of pests and diseases, (5) prevention of soil erosion, (6) the use of better agricultural implements and (7) the selection of right type of soil for a particular crop and the employment of a better system of crop rotation.

(1) *Better Seeds.*—While spectacular results have been obtained in plant breeding work so far as sugar cane and wheat are concerned, the same cannot be said about rice. A few heavy yielding strains have been developed by Dr Hector at Dacca but the better varieties of seeds are not available in adequate amounts. Investigations at Dacca University have shown that the nutritive values of different strains (of rice) are different and the cultivation of those strains that combine in them the qualities of heavy yielding and higher nutritive value should be encouraged. In each province a central organisation and general sub-stations for the multiplication and distribution of seeds of approved varieties of crops and vegetables, of sugar cane and of named varieties of fruit trees should be set up.

(2) *Manures and fertilizers.*—Intensive cultivation is impossible without intensive manuring. The yield of rice per acre in India (968 lbs.) is about half that in U. S. A. (1680 lbs.), less than half than that in China (2434 lbs.) and about one-third that in Japan (3070 lbs.). This is to a great extent due to the scarcity of manures and fertilisers. India produces about thirty thousand tons of ammonium sulphate while the rice fields alone should receive 7-8 lakh tons of the material per year. It has been pointed out in the Gregory Report that application of three and a half lakh tons of ammonium sulphate to 80—90 lakh acres of suitable land would increase the production of rice by about eight lakh tons per annum. The need for measures for starting factories to manufacture ammonium sulphate in requisite quantities cannot be over-emphasised.

Nitrogenous fertilizers usually give the best returns. Concentrated organic manures, oilcakes and fish manure also give good returns. Cheap and efficient manures can be prepared in large amount by the composting of organic matters in the farmyards and of the large quantities of town refuse and also of night soil. The step recently taken by the I. C. A. R. for the training of staff in methods of composting is a move in the right direction. The work should be taken up by the urban municipalities throughout the country without any delay. The practice of burning cow-dung as fuel should be stopped and cheap fuel should be made available.

(3) *Irrigation and drainage.*—Manuring can be successful only if there is an assured supply of water. Under the desert conditions such as those prevail in North Western India, irrigation is essential and it is also useful in other regions. Irrigation protects crop production from the vagaries of the monsoon and is an insurance against uncertainties of weather. Experts should indicate the means of utilising waters from the canals, from the great rivers, from wells fed by underground supplies and from tanks filled by rain. Opening of a great dam or barrage would also necessitate the selection of new varieties of crops suited to the new conditions and the designing of new cropping

schemes. Proper drainage of land is as important as irrigation. Large tracts of land in Bengal suffer from inundation and considerable volumes of water are often left stagnant thereby seriously interfering with the production of crops.

(4) *Control of pests and plant diseases.*—Insect pests and plant diseases cause serious loss to agriculture in this country. The loss can be minimised by developing resistant varieties of crops and by obviating the attack of the pest by changes in soil condition, by better drainage and by changes in methods of cultivation by earlier or later sowing. The disease-producing insect or fungus can also be destroyed by chemical or biological methods.

(5) *Prevention of soil erosion.*—Virgin soil maintains a cover of dense grass or forest which protects it against the disintegrating effects of rain and wind. With the increase in population, increasing demands are made upon soils and as a consequence the protecting cover is removed and forests are cut down to provide more lands for cultivation. The soil is then liable to be carried away by rain and also by wind. The affected area becomes useless, great ravines are scooped out as for instance in U. P. (8 million acres) and the soil that is washed away may injure the land on which it is deposited. Moreover the rain drops which would have soaked into the soil when the vegetation cover is intact, are lost as run-off water, carrying with it a heavy load of most fertile and absorptive surface soil and gradually increasing in volume and eroding capacity with subsequent showers. These little muddy waters as they find their way into the tributary stream or the main river, deposit at decreasing velocity some of the coarser particles on the river beds which are elevated in a few years to such an extent that the excess water pours over the country in uncontrolled flood causing destruction of life and crops and dislocation in the country's most vital links of communication. Deforestation of the catchment area of a river has been in fact the principal cause of soil erosion and recurrent floods. Heavy grazing also causes removal of the vegetation cover and soil erosion. A tract of land near Brindaban once most fertile has, as a result of continual over-grazing, been practically converted into a desert—a cattle-made desert extending over several hundreds of square miles in the heart of the world's most fertile plain. Wind also causes not inconsiderable loss of soil from the bare ground. In the bare fallow fields in the foothills of Northern India, except properly levelled land, a single storm leads to the loss of soil at the rate of 1¼ tons per acre. Clean cultivation of sloping land also causes soil erosion and ploughing along the contour lines instead of across them is to be recommended. Afforestation of the top slopes and bunding or terracing also have beneficial effects.

II. Utilisation of 'cultivable waste' lands:

It is also possible to increase production of food crops by bringing fresh lands under cultivation. Total 'cultivable waste' lands other than the 'current fallow' which is necessary to maintain soil fertility, amount roughly to 110 million acres. Assam, the Central Provinces, the Panjab, Madras and Sind are the provinces where these are mostly to be found. With a programme of land reclamation which would include anti-malarial and other public health measures and also provision of suitable labour, there is no reason why 80 million acres out of these lands should not ultimately be sown with food grains. Planned migration for agricultural colonization, as has recently been permitted by the Assam Government from the more densely populated areas, should also be encouraged. It is a matter of long-range scientific planning, is certainly an all-India issue and should be directed from the centre.

III. Replacing cash crops by food crops:

This would undoubtedly increase the amount of available food. India's agricultural economy requires careful planning by regulating the acreage under various food and non-food crops. Allocating acreage of a crop like jute and cotton to rival provinces is bound to give rise to controversy and should be considered as a part of the long range post-war reconstruction policy.

B. Development of Animal Husbandry and Fisheries

The inclusion of milk specially in the dietaries of infants and children and of expectant and nursing mothers has been deservedly a prominent feature of the nutritional propaganda within the last few years. In a country where the diet is mainly vegetarian, a satisfactory maintenance of human health is impossible without the consumption of milk and dairy products. Including the consumption of ghee and butter which is confined only to the relatively richer classes, the average milk consumption per day per person in this country is only about 10 oz. The production should be at least three times as much to ensure a satisfactory standard of health and physique in people. The difficulty is not lack of sufficient number of cattle in this country which possesses 300 million animals excluding pigs and poultry. The United States of America which possesses the second largest animal population in the world contains only 140 million animals excluding pigs and poultry. The small amount of milk produced by the average cow in India is the greatest limiting factor to an increased consumption of milk. Proper feeding and management would greatly increase the milk yield. The milk yield of the best Indian cows compares very favour-

ably with that of the average English dairy cattle and the yield can further be improved by selective breeding.

It must not be forgotten that agriculture in India is wholly dependent on the cattle population for the bullock draws the plough, supplies the manure, threshes the corn and also pulls the cart. The need in India is for better cattle. Provision of fodder for the cattle is an urgent problem. This is hardly possible unless the productivity of the Indian soil is increased which will permit a part of the lands to be used for the production of fodder crops.

Attempts should also be made to develop the industry of meat production. This would provide additional nutritious food and also an outlet for animals not required for milk production and for work in the fields. Prejudice against the taking of meat has no scientific basis and should be got rid of by education and propaganda.

Reference should also be made to the value of eggs as food and the need for developing the poultry industry in India cannot be over-emphasised. The egg is a valuable protective food, and a rich source of high quality proteins, vitamins A, D, B, riboflavin and of iron and in a way supplements milk. It would not be difficult to develop this industry in this country. Striking results obtained in the egg yielding capacity of hens by careful and selective breeding should also be attained with the duck.

The development of fisheries would provide another important and valuable source of highly nutritious food. This industry has got immense potentialities. The sea fisheries--both coastal and deep sea—of Indian waters can provide a vast quantity of food and fish manures as a by-product. The shark can supply the entire amount of vitamins A and D needed in this country and obviate the necessity of importing codliver oil.

The role of Synthetic Vitamins and Vitamin concentrates in raising the level of Nutrition

The question of attempting to improve the nutrition of the entire population by the use of vitamin concentrates and synthetic vitamins has been frequently raised. There is no substitute for a good diet of ordinary mixed foods but when natural sources are not available in adequate amounts, the synthetic vitamins and vitamin concentrates can of course play an important role. Young children and pregnant women very frequently require certain vitamin supplements even during normal times. The availability of synthetic products in India presupposes an industrialisation of the country. Yeast and shark liver oil, on the other hand, will be available and full use should be made of them. The shark liver oil industry developed in this country during the present war should be protected from foreign competition. Liver extracts also can play an important role and it should be possible to have large supplies of these made in India. Margarine and vegetable fats should be fortified with vitamin concentrates.

Need for Nutritional Research

All progress is based on research and the knowledge that has accumulated from nutritional investigation during the last decade has thrown into clear relief the contribution which nutritional research can make to human welfare. In all civilised countries faced with food problems very large sums are being spent on research to solve the immediate and pressing problems as also on long-range research. India has her own peculiar problems in nutrition and it will be an extremely short-sighted policy not to give adequate funds for nutritional research.

Food Departments—Central and Provincial

Not only should sufficient food be produced in the country but also it should be fairly and equitably distributed among the entire population. The task of distribution is primarily administrative and this and related problems can best be tackled by the creation of permanent food departments in the centre and also in the provinces and States. The Central Food Department should formulate and initiate policies which should mostly be carried through by the provincial food departments over which the centre must have sufficient control. Intelligence and statistics bureau in the central food department should be a very important section which should maintain intimate contact with all phases of the food situation. There should be a half-yearly stock-taking of all the available foods in the country. There must be licensing and registration of the regular trader and information about what supplies he has received and from whom, to whom he has sold, should always be available. Knowledge of stock in the possession of agriculturists should also come into the possession of the Government. The department should arrange for the transport of food grains through a movements officer. If faulty diet is to be eliminated, the purchasing power of the poorest must be related to the price of a diet adequate for health and hence the necessity of price control. Rationing 'ensures the equitable distribution of an insufficient food supply' and it may be necessary to introduce and continue rationing in India as a general policy. In this and other spheres of administration the food department must have the benefit of the advice of nutrition ex-

perts. Some of them should be permanently attached to the department. The experience and knowledge of the others may be utilised by forming an Advisory Board on which they may be invited to serve. The success of the department demands that it should be efficiently and adequately staffed. Publicity and propaganda should be an important feature of the department.

The Population problem and Nutrition

The problem of the relation of food supply to population is a very intricate and highly controversial one. The prevailing view seems to be that the growth of population and the growth of food supply in India not having kept the same proportion in their rise, there is a lag between food and population with the result that a condition of over-population and even of saturation has been created. Closer examination will however, show that there is no justification for this extremely pessimistic view.

Undoubtedly there is a slight shortage of food supply in the country at present. The acreage per capita under food crops in India is about 6·86 acre compared with 4·2 acres in U. S. S. R., 3·3 acres in U. S. A. and 0·36 acre in China and compared with East's minimum of 2½ acres per head as representing the area necessary for producing enough food. Utilisation of cultivable waste and great and fundamental changes in agricultural technique which would vastly increase the productivity of the cultivated areas can surely create a saisfactory food position in India.

The population problem cannot be discussed only in terms of food supply within the country. If that were so, England would have been saturated with population nearly 2½ centuries ago. The ability of a country to maintain an optimum population depends upon its agricultural, as well as commercial and industrial wealth. It should be the aim of post-war reconstruction programmes to increase the per capita income of the Indian people by 100 per cent and to provide a more balanced economy. Instead of the contribution of industry, agriculture and the services to the national income being as it present 17· 53 and 20 per cent respectively, the percentages should rather be 35, 40 and 20 respectively. This would necessitate a rapid development of industries. Economic considerations play a very important role in matters of nutrition and an inadequate family resources are the greatest single cause of defective nutrition. The population problem in India does not necessarily mean the problem of birth-control. The most obvious and urgent problem to-day is to raise the standard of life, of education, of sanitation, of agricultural production and of vitality through vigorous and persistent State action.

BOOK REVIEWS

"Geology of India and Burma"—By M. S. Krishnan, M.A., Ph.D., A.R.C.S., M.A.I.M.E., Geological Survey of India. (The Madras Law Journal Office, Madras) 1943, pp. XVI+518. Price Rs. 15/- net.

Dr M. S. Krishnan must be congratulated for bringing out a comprehensive and up-to-date text book of high standard on "Geology of India and Burma" for the students and the educated public who are interested in this science. The first text-book on this subject was the official Manual of the Geology of India in two volumes by H. B. Medlicott and W. T. Blanford published by the Geological Survey of India in 1879. This was revised and rewritten by R. D. Oldham in 1893 which was out of print by 1910. Although the Manual was an excellent official record of work upto that time it soon became out of date and besides its voluminous size the method of treatment was not suitable for average student. The latest and revised edition of this Manual has however been prepared by the Geological Survey of India after half a century and is now ready for the press but would be published possibly after this war is over.

In 1910 a very small book on this subject entitled "A summary of the Geology of India" was published by E. W. Vredenburg, an officer of the Geological Survey of India. As this was too short a summary of a subject which was gaining importance it could not satisfy the student community as well as other inquirers. The publication of this book was however discontinued after second edition. So the active workers in this line were forced to search for and collect information from the innumerable issues of the *Records* and *Memoirs* of the Geological Survey of India—a very difficult task for the diligence of the

average student. Moreover these official publications are not easily accessible and are only to be found in very few libraries of this country.

It was in 1919 that the first handy volume of an excellent nature on this subject, written in a masterly way, was published by D. N. Wadia, the then Professor of Geology, Prince of Wales College, Jammu (Kashmir) and the subsequent editions have since been supplying adequate information to the student community.

Quite recently in 1943 M. S. Krishnan, an officer of the Geological Survey of India, has brought out another text-book on "Geology of India and Burma" which is quite welcome to the students and others interested in this science. A new book on Indian Geology needs no apology for its appearance especially because this subject is attracting greater attention of the various institutions of this country and an increasing number of students.

Krishnan's book under review consists of 518 pages in all and divided into 20 chapters. The first chapter of 40 pages on Physical Geology of this country deals briefly with climate, mountain systems of peninsular and extra-peninsular India, glaciers, rivers, lakes, earthquakes and volcanoes. The origin of mountains, lakes etc. and an account of change of some of the river courses would be of great interest to the readers.

The second chapter consisting of 33 pages gives a very good summary of the structure and tectonics of India and Burma, a subject of great importance to every student of Indian Geology and this constitutes a special and additional feature of Krishnan's book. It may, however, be said that in several cases the generalisations are only tentative ones and need verification and confirmation by further field work and investigations. A few diagrams illustrating the structural features would have been very helpful to the younger students. A paragraph regarding the evolution of the configuration of India through the various geological periods illustrated by sketches would have been of greater attraction to the readers. The local students of Bengal will find much interest in the story of the evolution of the Bay of Bengal.

The third chapter gives a general review of Indian stratigraphy and includes several tables showing the general geological formations and stages and a detailed scheme illustrating the correlation of the geological succession in different parts of India and Burma.

In chapters IV and V a detailed account is given of the Archaeans of the Peninsula including Ceylon and the extra-peninsular region including Burma. About 60 pages have been adequately devoted to this important subject. The proper correlation of the Archaean formations at different places has ever been a great problem to the Indian stratigraphers and the student community was always in a great fix in obtaining a clear understanding of this subject as no suitable and systematic account could be found on a small compass in any of the previous text books. Dr Krishnan who has a first hand knowledge and sufficient experience in several of the places where this formation exists has done good justice to this subject by summarising all available information and in giving his suggestions on various points.

The division of the Archaean group into an Archaean system and a Dharwar system as has been done by Wadia has not been carried to the extent of describing each as a separate unit, since the two are very closely associated and since the granites and gneisses may merely represent certain horizons within the schistose members. A good summary of Mysore Archaean complex has also been given and the latest views of B. Rama Rao regarding the sedimentary origin of a considerable portion of the Dharwars have been included. Much credit is due to the author for the way in which he has presented this complicated subject and for the inclusion of several tables showing correlation. This is another attractive feature of the book under review. Krishnan has admitted that the complexity of the Archaeans prevented him from attempting more than a broad indication of correlation and that further intensive work would be necessary in order to put forward an acceptable scheme of detailed correlation.

The chapter VI gives a very brief account of the economic mineral resources found in the Archaean formation. The economics of each of the geological systems are given at the end of the respective chapters. This is another special feature of this book and is considered to be decidedly an improvement on the old practice.

A major portion of the important economic minerals of India is found in the Archaean formation because extensive mineralisation took place along with the widespread igneous activity in the different parts of this country during that old geological period.

This chapter would have been of greater interest if it included a fuller and more complete account of the economic minerals together with a map of India showing their distribution. A point may be raised as to whether we should include lateritoid manganese ore deposits in the Archaean formation or within the Pleistocene deposits. From the standpoint of the geological age it should be included within the Pleistocene system.

The chapters VII and VIII deal with the Cuddapah and Vindhyan systems together with the economics at the end of each chapter.

The Palaeozoic Group is described in chapter IX. The Salt Range geology is discussed and the interesting account about the age of the Saline Series has been given.

There has been certain amount of controversy between two officers of the same department on this problem. Fox showed that in certain clear sections in the *cis*-Indus Salt Range the Saline Series lies below the Cambrian succession without much visible signs of disturbance. Gee on further work found evidences of a *nappe* and advocated an Eocene age for the Saline Series but recently he has revised his opinion and now supports a Cambrian (or Pre-cambrian) age for that of the Punjab Salt Range. Future work only can reveal the truth.

The sedimentary formations have been described with the help of a number of geological sections. A new and useful feature in this book is that each sedimentary group is illustrated by plates of characteristic fossil types.

The chapter X of 54 pages gives an adequate information on the Gondwana system which is the chief coal bearing formation of India. The two-fold classification of the Gondwana system as adopted by the Geological Survey of India has been adhered to in this book. The tripartite classification as adopted by Vredenburg and Wadia has also been discussed. Though the occurrence of arid continental deposits containing Triassic reptiles and amphibians make the tripartite division plausible, the evidence of the flora is entirely in favour of a two-fold division. Geological sketch map of Jharia and Raniganj coalfields, a map showing the distribution of the lower Gondwana coalfields and a number of tables and plates showing the important plant fossils are given to illustrate the chapter. The names of the more important coal seams occurring in the Jharia and Raniganj coalfields and the nature of the Barakar and Raniganj measure coals have been given. The estimates of the coal reserves of these two coalfields and the classification of coal adopted by the Coal Grading Board have also been included.

The remaining 10 chapters deal with the younger geological formations. Chapter XV gives a very good account of the structural features, petrographic and petrological characters, chemical composition of the Deccan Traps. The age of the Deccan Traps has been discussed from the fossil content of the inter-trappean and infra-trappean beds as well as from the recent radio-active characters of the traps.

The chapters XVI to XIX give a balanced description of the systems of the Tertiary Group found at different places of India and Burma. The Eocene System contains important deposits of coal in Assam, N. W. India and Burma. The story of the upheaval of the Himalayas has been nicely presented.

In chapter XX the Pleistocene system is discussed. The Pleistocene Ice Age and the results of recent work by H. De Terra and others have also been incorporated. The characteristics and origin of the Indo-Gangetic alluvium and other alluvial deposits have also been dealt with as well as the recent changes in the coastal tracts. Lastly a short account of laterite, its characters, composition, mode of formation and uses have been enumerated.

A selected bibliography has been given at the end of each chapter for reference and 16 pages have been devoted to the Index of the book. An addition of a geological map of India would have enhanced the value and usefulness of the book to a very great extent. The second edition might possibly include one.

Finally one word may be said with regard to certain geological formations derived from topographical names, *e.g.*, Kadapa, Bundair, Vempalle, Varkala, Damodar etc. Krishnan has introduced these terms which are not yet accepted or included in Holland's "Geological Terminology". In this connection it has to be remembered that once the name of a geological formation is coined and incorporated in the bibliography it should never be changed in future and such terms should have priority of claim and should be considered to be absolutely rigid. If this view is not accepted by all it is desirable that definite and specific terms should now be standardised and accepted once for all in order to avoid several confusing terms for one particular formation.

The get up and printing of the book under review have been quite satisfactory and upto the mark and considering the high cost of printing and scarcity of good paper due to war conditions the price has been quite reasonable and is well within the reach of almost every student. Few inaccuracies and printing mistakes have however crept in possibly due to the unusual hurry in getting the book through the press and it is hoped that these defects would be eliminated in the second edition.

The book is really brought up to a very high standard as it contains a summary of almost all the important recent work done on Indian stratigraphy and if the few suggestions for improvement that are given in this review are carried out in the next edition the book will surely be of immense value and of great use to all who are interested in this subject. There is every reason to believe that a book of this nature will be very popular among students and other workers in Indian stratigraphy.

N. N. C.

Indian Ephemeris of Planets' position—according to the Nirayana or Indian system for 1944 A.D. —By NIRMAL CHANDRA LAHIRI, M.A. Published by the Bharati Mahavidyalaya, 170, Manicktalla Street, Calcutta. Pages 56, Price Re. 1/-.

Astronomical Ephemeris contains tables showing planetary co-ordinates for each day. The present Ephemeris under review contains daily longitudes of the Sun, the Moon and the planets, sidereal time for noon, latitudes, declinations and meridian passages of planets for each alternate day, and many other astronomical data mainly required by the astrologers. Students of astronomy would also be benefited by this booklet, as the planetary position given therein would help them to identify the planets. The longitudes and latitudes of principal stars that have been given in this Ephemeris will be found very useful for researchers in Hindu astronomy. As the booklet is intended for Indian students, the planetary positions on the Nirayana basis have been given instead of on the Sayana or tropical basis. We hope that it will prove very useful to those who are interested in astronomy as well as in astrology.

M. N. S.

Intermediate Practical Physics—By D. B. SINHA, Bodern Book Agency, Calcutta. Price Rs. 2/-.

The writing of a practical book on science course always seems to be a difficult job. It is particularly so if such a book is intended for young students going for the first time to cultivate their acquaintance with science and its methods. Creation of the habit of systematic observation and methodical procedure during the conduct of an experiment with a real dislike for mechanical approach without understanding and, above all, of an abiding interest in the principles and methods of science should and must be the aim in writing a practical book on a science subject, on physics in particular. It is not unoften that such books fail to fulfil this aim and that new publications are hardly any improvement on old ones. Mr Sinha's 'Intermediate Practical Physics' appears from these considerations to be a real improvement on the number of practical books now in existence. The happy choice of experiments, the simple and accurate description of the methods, reproduction of neat diagrammes, tables and graphs, wherever necessary, and various notes and suggestions for success in experiments are largely calculated to fulfil this aim which alone justifies its publication, and as such the book deserves wide notice among teachers and students of Indian universities.

S. N. S.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

ON BALANCING PARAMETERS

It has been observed in the papers,[1, 2] written by the author that the design of experiments consists of the fundamental problem which is sought to be solved with the help of the problem of balancing, which depends on the information supplied by the design on estimable parametric functions. Information on any parametric function can be obtained by comparing its efficiency with the efficiency of its estimate from a standard design. We say that there is balance with respect to a set of independent parametric functions if the information as calculated above is the same on all. It has been already shown that if there is balance with respect to a set of independent parametric functions then the information on any linear function of the parametric functions is equal to the loss on any one of the latter functions. A discussion of the problem of balancing which consists in the choice of balancing parameters is given in this note. The details of the proofs of the various statements will be given in an elaborate paper to be published in *Sankhya*.

The fundamental problem is that there are v treatments (varietal or factorial) to be tested in b blocks of sizes $k_1, k_2, k_3, \ldots\ldots k_b$, the i-th treatment being replicated r_i times and the i-th and the j-th treatments occurring together λ_{ij} times. The analysis of this general design has been given by the author[1] and it was found that the estimating equations are

$$\sigma^2 Q_i = V(Q_i) - \Sigma \operatorname{cov}(Q_i Q_j) \quad . \qquad (2.1)$$

where Q_i = the sum of observed yields on the i-th treatment -- the block means in which it occurs.

In the case $k_1 = k_2 = \ldots\ldots = k_b = k$, the equation (2·1) becomes

$$Q_i \cdot \underset{i \neq j}{\Sigma} a_{ij} t_j \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2.2)$$

where $a_{ii} = \gamma_i (k-1)/k$, $a_{ij} = -\lambda_{ij}/k$

and t_j is the j-th treatment effect.

The matrix $A = (a_{ij})$ plays the fundamental role in our investigations. The following properties have been found out.

(*a*) The rank of A is less than v and is equal to the number of Q's which are linearly functionally independent.

(*b*) There exists a dual relation between the Q's and the t's such that if

$$\Sigma C_i Q_i = 0 \quad . \quad . \quad . \qquad . \quad (3b.1)$$

then the parametric function

$$\Sigma C_i t_i \quad . \quad . \quad . \qquad . \quad (3b.2)$$

cannot be estimated, so that the number of degrees of freedom confounded is equal to the number of independent linear functional relationships among the Q's.

(*c*) There cannot be any non-vanishing linear function of Q's whose expectation is zero.

(*d*) A linear combination of non-estimable and estimable parametric functions is also non-estimable provided the co-efficients are not such that the linear function of non-estimable functions becomes null.

(*e*) If the rank of $A = (v-1)$ then

(*i*) the co-factor of a_{ii} is +ve and is independent of i

(*ii*) the treatment differences are uniquely estimable and

$$V(t_i - t_j) = \frac{\text{co-factor of} \begin{pmatrix} a_{ii} & a_{ij} \\ a_{ij} & a_{jj} \end{pmatrix}}{\text{co-factor of} \quad a_{ii}}$$

(*f*) If, in general Σ a Q and Σ b Q are the estimates of Σ lt and Σ mt then their variances and co-variances are

$$\begin{pmatrix} \Sigma\, a\, l & \Sigma\, a\, m \\ \Sigma\, b\, l & \Sigma\, b\, m \end{pmatrix}$$

(*g*) Every design can be broken up into parts in which (*e*) holds good.

This result is independent of the restriction of the equality of block sizes.

With the help of (*e*) it has been found that the balancing parameters introduced in the case of partially balanced[3], intra and inter-group balanced[4], quasifactorial[5] and balanced factorial[6, 7] (symmetrical or asymmetrical) designs come out as solutions to a mathematical problem. Several hybrids of these designs have been incidentally found out.

Certain methods have been developed to investigate into the role of the balancing parameters in the confounded arrangements of the symmetrical factorial designs and the conditions under which the principle of the generalised interaction[8] holds good have been studied.

Some results in the third paragraph are true, in general, for the estimating equations of a set of observational equations with expectations as linear functions obtained by the method of least squares.

C. RADHAKRISHNA RAO

Statistical Laboratory,
Calcutta, 18-1-1944.

[1] Rao, C. R., Thesis submitted to the Calcutta University, 1943.
[2] ——————Current Science, 12, 322-23, 1943.
[3, 4, 5, 6, 7] Nair and Rao, SCIENCE AND CULTURE, 7, 313, 1941 7, 361, 457, 568, 615, 1942.

RADIO INVESTIGATION OF AIR MOVEMENT IN THE UPPER ATMOSPHERE

INVESTIGATION of eddies and circulation in the earth's upper atmosphere may be greatly aided by reduction of observations of long-range very-high frequency radio signals. It is fairly well known that propagation of wave trains of the order of 60,000 kcs./sec. is possible from small plane areas, or patches, or clouds of extremely high ionic density within the "E" region. This is commonly referred to as sporadic "E", (E_s).

A consideration of a particular manifestation of E_s has been examined by the writer. Very extensive observations in North America on June 5, 1938 and July 22, 1938 have been reduced. On both occasions the apparent skip distance was observed to drift at a specific rate of speed.

The skip distance, or the far boundary of the zone of silence, on the first occasion progressed 850 km. in 1 hour and 50 minutes. On the latter occasion, it was observed to progress over 900 km. in 1 hour and 40 minutes.

With correlating data from the Cheltemham Magnetic Observatory on the virtual height (115 km.) and ionic density (exceeding 3.5×10^6 free electrons per c.c.) an estimate of the lateral drift of the sharply-defined discontinuity was prepared. The average velocity of drift was found to be 120 km/hour. In the first case the eddy was indicative of an easternly air current. In the latter the flow was apparently from the southeast.

Through the co-operation of Dr Charles P. Oliver, Director of the Cook and the Flower Astronomical Observatories, twenty-five selected long-enduring meteor trains were applied as a partial confirmation of this hypothesis[1]. It was immediately noticed that the predominant drift over the North American continent was to the north, tending west. The average of the two values, measured and assumed for night trains at 88 km. was 194 km./hour. Although there were indications of increasing circulation with increasing heights no specific inferences could be drawn. Undoubtedly, however, considerable instability exists in this region.

The findings of Dr Oliver were in opposition to those of Kahlke[2]. Turbulence and eddies of 100 km./hour at heights from 60 to 110 km. are among his 26 observations. Kahlke and Barnard[3] utilizing 80 examples found a prevailing easterly movement at night, indicating a west wind.

Theoretically, if the atmosphere at 40 km. becomes a few degrees warmer during the daylight hours, air circulation will be from the night areas to the daylight areas at certain heights. At nominal altitudes above this the prevailing wind shall be continually 180 degrees out of phase. The establishment of these heights can be greatly aided by reduction of variations in the skip distance during periods of E_s.

O PERRY FERRELL

U. S. Army Forces, (A.S.N. 32268682)
Chittagong, 15-2-1944.

[1] *Proc. Amer. Phil. Soc.*, Oliver, C. P., 85, 2, 1942.
[2] Meteorschweife und Hochatmosphärische Wind stromungen, *Ann. Hydrogn.* 49, 294-299.
[3] *Sidereal Messenger*, 1, 174-180.

TOTAL ALKALOIDS IN *ALSTONIA SCHOLARIS*

I

THE letter published by Mr J. N. Rakshit in SCIENCE AND CULTURE (9, 302-303, 1943-44) under the above caption needs some comments since he makes certain statements which are open to correction.

The author suggests a new method for the isolation of total alkaloids and has further recommended this method for commercial and pharmaceutical valuation. He has by his method, discovered the presence of *2.9 to 11.2 per cent* of 'total alkaloids as sulphates' in the dried bark, whereas all previous workers[1] have never found in any of the ten *Alstonia* species so far studied, *e.g.*, (1) *Alstonia constricta*, (2) *A. macrophylla*, (3) *A. somersetensis*, (4) *A. villosa*, (5) *A. verticillosa*, (6) *A. scholaris*, (7) *A. angustiloba*, (8) *A. congensis*, (9) *A. gilletii*, (10) *A.*

spathulata any figure higher than 1·61 per cent (variation—0·1 to 1·61 per cent) as 'total alkaloids'.

We need not at all refer to our own finding[4] which have only corroborated the above. The authorities on alkaloids did not of course "presume" that all water-soluble substances having basic properties were 'alkaloids' and hence they never attained a figure as high as 11·2 per cent.

The author has taken his second stand on the *better* antimalarial action of the 'total alkaloids' isolated by him in comparison to those isolated by 'standard' methods. We shall eagerly await the publication of these figures which have been "investigated by medical men exhaustively" but it is perhaps quite pertinent to remark that a "febrifuge" is not necessarily a specific "antimalarial". A temporary reduction in temperature is often brought about by a host of so-called 'antimalarials' but a *real* antimalarian from natural sources to replace quinine is yet to come.

A. T. Dutt

Department of Chemistry,
School of Tropical Medicine,
Calcutta, 22-2-1944.

[1] Henry, 'Plant and Alkaloids', 3rd Edition, 1939.
[2] Wehmer, 'Die Pflanzenstoffe', 1930.
[3] *Jour. Chem. Soc.*, 2626, 1932; 287, 1934; 1227, 1934; 1353, 1938.
[4] Mukherji, Ghosh and Siddons, *Ind. Med. Gaz.*, 77, 323, 1942.

II

The following fundamental properties of vegetable alkaloids were missed by former investigators on this drug:

(1) *Solubility*—Several prominent alkaloids (like morphine) are quite sparingly soluble in immiscible solvents, which were used in extraction of bases from *Alstonia* barks.

(2) *Stability*—Some alkaloids are weak and cannot stand alkalies, and this fact was formerly recorded by Sharp[1].

Consequently attempts to support the previous results cannot be justified. Pending completion of my research I note that some of the *Alstonia* alkaloids are like morphine in solubility, and delicate like several others present in opium. The so-called authorities will miss most of morphine if they apply their old method to opium or poppy capsules for extraction of total alkaloids.

Medical men, including Dr Bidhan Chandra Roy had already expressed their views in daily papers about curative properties of these long over-looked alkaloids. I however, did not notice any report from these men with vast private practice whether they tried the drug on the monkey or the bird. It will not be wise in this connection to ignore that some cases of malaria are self-terminating, and an appreciable proportion of popularity of quinine is due to this fact.

J. N. Rakshit

Calcutta, 15-4-1944.

[1] Sharp, T. M., *Jour. Chem. Soc.*, 288, 1934.

EFFECT OF VERNALIZATION AND PHOTOPERIOD ON LATE SOWN AMAN PADDY

The extensive loss of aman paddy by floods in different parts of Bengal is well known. In these areas the cultivators try a second crop, after the flood has subsided. But the yield of these sowings is very meagre, owing to the shortness of the vegetative period. Experiments in the Department of Agriculture show that the flowering of aman paddy is fixed within a short range of time, in the latter half of October in var. Bhasamanik and Jhingasail, even with wide difference in sowing time (February to August), and if the sowing be greatly delayed (October to December) plants remain vegetative in the winter, flowering in March-April. Sircar[1] observes that aman paddy flowers with the approach of short days of winter and has reported an earliness of flowering in plants exposed to short photoperiod.

It thus becomes a great interest to investigate how far late sowings after the flood has subsided can be made to flower earlier and produce better yields by presowing low temperature treatments and by photoperiodic effects. The following experiments were therefore designed, growing a high yielding var. Bhasamanik in suitable pots with sufficient number of replicates. Seeds of all the treatments were sown on 2-9-43 and the results are given below.

Vernalization: Seeds were soaked in water for 48 hours and vernalized at 2-4°C. in a moist chamber for 10 and 20 days and sown in pots with untreated seeds as control. It was found that the treated plants in both the sets flowered about 10 days later and the plants showed general deterioration in their growth and general vigour.

Photoperiodic effects: Seeds vernalized at 2-4°C. (1st set) were sown with untreated seeds (2nd set) in pots and exposed to 8 hours sunlight daily,

by transferring the pots to a dark room for about 3 hours in the afternoon for 20 days. Seedlings of these two treatments as well as those which served as controls were transplanted after 20 days. It was found that in the 1st set exposed to short photoperiod after low temperature treatment flowering was delayed by 9 days and in the second set exposed the short photoperiod by 16 days. In this case also the treated plants showed a deterioration in their vegetative growth and general vigour.

It is thus seen that presowing low temperature treatments and exposing the seedlings to short photoperiods in late sown aman paddy delays the onset of flowering and there is no increase in vegetative growth and yield. It will however be of interest to investigate how far presowing high temperature treatment is of influence to aman paddy in view of the fact that Hedayetullah and Sen[2] recorded an earliness with increased yield due to such treatment and there are similar records with many other tropical plants.

J. C. SEN GUPTA
NIRAD KUMAR SEN

Botany Department,
Presidency College,
Calcutta, 27-3-1944.

[1] Sircar, S. M., Photoperiodic response in one variety of winter paddy, *Jour. Ind. Bot. Soc.*, pp. 41-50, 1942.
[2] Hedayetullah, S. and Sen, Nirad Kumar, Vernalization of Rice, SCIENCE AND CULTURE, 9, 668, 1941.

THE SEED STRUCTURE OF IPOMOEA, A CRITICISM

AN abstract of a paper by Dr Woodcock[1], which has just come to hand, says that in *Ipomoea rubrocaerulea* Hook. the ovule "has no distinct integument and the micropyle is formed by an invagination at the end of the ovule next to the funiculus". The statement regarding absence of a "distinct" integument is astonishing as it is not borne out by the figures or descriptions of any of the previous workers on the family or even the genus *Ipomoea*. Kenyan[2], Juliano[3] and Raghava Rao[4] have all reported a massive integument and a long and narrow micropyle in a number of species of *Ipomoea*.

Unfortunately Dr Woodcock's full paper is not available at the time of writing but from the summary (prepared by his own self), it appears that he did not study the initial stages in the development of the ovule. An integument is certainly present but the nucellus is ephemeral. The micropyle cannot be an "invaginaton" but a continuous passage extending from the surface of the ovule right up to the embryo sac. After fertilisation has been accomplished it begins to be occluded and is probably not anatomically demonstrable except in the distal region of the ovule, thus giving the false impression of having arisen as an "invagination". In non-median sections it may not be seen at all and either the integument may then be mistaken for the nucellus, which is however no longer present, or no distinction between the two tissues may be apparent even to a trained observer.

Even so recently as 1938, Houk[5] failed to see a separate nucellus and integument in coffee and in his confusion stated that the tissue in this region should be regarded as "integument-nucellus". Mendes[6] and several other workers have however proved that both nucellus and integument are formed quite normally but the former soon disappears as is usual in most Sympetalae. In another genus, *Fouquieria*, Johansen[7] described a "massive" nucellus, but Khan[8] has shown that what he was looking at was the inner integument and that the nucellus had disappeared long before.

The morphology of the seed is so difficult that it is often quite impossible to understand it correctly without first studying the stages leading to its development. If one has only the older stages before him, he is very apt to mistake two adjacent tissues for each other, or get into a muddle in trying to account for two tissues (integument and nucellus) when one (the nucellus) has already degenerated and disappeared.

Botany Department,
Dacca University,
Dacca, 11-4-1944.
P. MAHESHWARI

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[3] Juliano, J. B., Morphology of the sweet potato, *Ipomoea batatus* (Linn.) Poir. *Philippine Agri.*, 23, 833-858, 1935.
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[8] Khan, Reayat, The ovule and embryo sac of *Fouquieria*. *Proc. Nat. Inst. Sci. India*, 9, 253-256, 1943.

CULTURE OF *DAPHNIA*

Rearing fish in ponds depends much on proper food supply. Among various kinds of food, microscopic crustaceans form an ideal food for fish in general and some of the major Carps[1] in particular. The acute demand of the three fundamental ingredients of food material namely, carbohydrates, proteins and fats can readily be got in a crustacean like *Daphnia*—the microscopic water-flea.

Culture of such minute crustacean like *Daphnia* is essential as they are thinned out at least for two periods during a year *i.e.*, in July-August and December-January. The flourishing periods for *Daphnia* have two seasons in a year, one from February to April and another from September to November. Their rate of growth goes down after April as majority of them cannot stand a temperature higher than 82°F. *Daphnia longispina* forms the best type of food-crustacea as it can stand the greater range of temperature from 70°F. to 82°F. and also alkaline water, while other allied crustaceans like *Bosmina*, *Moina* and *Ceriodaphnia* cannot tolerate such high temperature nor high alkaline water. Most of the *Daphnia* have decided tastes regarding food. *Daphnia longispina* prefers green algae whereas *Bosmina* and *Ceriodaphnia* like Diatoms and Protozoa. For this sort of variation regarding preference of food one must acquaint himself with the food-habit of a particular crustacean before he can try for its culture.

Breeding of *Daphnia* has two definite forms of reproduction: (1) asexual, (2) sexual. The first form of propagation is done by parthenogenetic females which can produce eggs that develop into adult forms without being fertilized by a male. The number of eggs in such females varies, in minute *Ceriodaphnia* the number is only two, but the usual number in large *Daphnia* is more than twenty. Such eggs are nourished in the brood-case till they are hatched out as minute adults. This mode of reproduction goes on regularly until the advent of the unfavourable circumstances, such as, variation of temperature, accumulation of excessive metabolic waste products, external enemies, over population and scarcity of food. With the advent of unfavourable conditions mentioned above normal females and males are hatched from such parthenogenetic eggs. These normal females can produce one or two large and opaque, thick-walled eggs. These are called the winter-eggs although they have nothing to do with winter season, specially in a tropical country. Such winter-eggs are lodged in special chamber called ephippium till the next favourable season for development.

From the above data it is evident that in order to have a controlled breeding of *Daphnia* we should concentrate our attention to have an artificial culture of parthenogenetic females which can produce *Daphnia* for the greater period in a year. To have a dense culture of *Daphnia* several kinds of fertilizers such as soyabean, dried milk products, raw meat, blood, manure of chicken, have already been advocated by previous workers. The above fertilizers are admirable for aquarium but they are almost useless for bigger waters such as ponds and lakes, not only for their procurement but also due to excessive cost in a poor country like India.

In order to have a continued mass culture of *Daphnia* at a minimum cost, the following methods may be adopted. If we have five large cement tanks or five earthen 'gamlas' with thin cement coating, then these can be used as vessels for culturing *Daphnia*. Green algae and cow-dung can be used as a manure for culturing such *Daphnia*. The satisfactory result can be had within twenty one days, by adding five gallons of deep green water (algae) and ten pounds of fresh cow-dung in hundred cubic feet of water. We should not start culturing *Daphnia* in these 'gamlas' all at once but should use each 'gamla' at an interval of five days, so that after three weeks we will be able to use the culture of the first 'gamla' for a period of five days. By that time the second 'gamla' will be matured for use for a period of next five days and so forth; so that after five such operations, we should repeat the entire process again with first and the next four in a linear series. This method will enable us to give a continued supply of *Daphnia* without the advent of unfavourable circumstances mentioned above which develop the normal male and female from parthenogenetic eggs ultimately forming winter-eggs.

The most useful and everlasting way of maintaining the seeds for culturing *Daphnia* which has not been recorded by previous workers is to keep the winter-eggs which can be had readily by drying up of the culturing 'mamlas'. These winter-eggs will lie in a dormant state for a good length of time and on getting in touch with water they will readily germinate. We have observed in many occasions such germination of winter-eggs on coming in contact with water.

Lastly we like to suggest another easy method of culturing *Daphnia* which in reality turning a curse to a blessing. We have often observed that whenever the covering plants like water-hyacinth or pistia are removed from the water surface of a pond to the adjacent area for drying and when these dried water-hyacinth or pistia are again put into the pond either accidently or wilfully they act as a very good manure for culturing *Daphnia*, a few of which are already in the pond. They act as seeds and germinate to a huge quantity that it can serve the purpose of

feeding the fry and fish in adequate quantity in any pond.

We have much pleasure in thanking the Adair Dutt Research Fund Committee of the Indian Science News Association for the scholarship which enabled us to carry out the work.

H. K. Mookerjee
S. N. Ghosh

Zoological Laboratory,
University Science College,
Calcutta, 17-4-1944.

[1] Mookerjee, H. K., Food of Fresh water fish. Science and Culture, 9, 306, 1944.

ON THE LACTIC ACID FERMENTATION OF MOLASSES BY *LACTOBACILLUS BULGARICUS*

One of the most important uses for *Lactobacillus bulgaricus* has been in the commercial production of lactic acid from some cheaper source of carbohydrates such as whey. But the production of the acid is in many cases a slow process. Recent researches[1, 2, 3, 4] however tend to show that the fermentation may be accelerated by incorporation of some accessory nutrients like riboflavin, pantothenic acid and/or nicotinic acid. Pan *et al*[2] have noticed that in the fermentation of molasses by a selective strain of *L. delbruckii* malt sprouts alone serve as the proper nutrient source. In order to shorten the period of fermentation attention has also been diverted towards certain other factors such as the concentration of sugar, maintenance of *p*H on the acid side, and the temperature of the fermentation.

In connection with a lactic acid fermentation work that is being carried out in this Laboratory, it is being noticed that a mash made from inverted molasses and adjusted to contain a sugar concentration of about 10 per cent, undergoes fermentation with a culture of *L. bulgaricus* maintained on sterilized skim-milk, even when incubated at 37°C—the accessary nutrient being supplied from yeast extract. Substituting the yeast extract by a concentrate from liver extract, the sugar is being found to undergo about 60 per cent conversion within 24 hrs. and to complete fermentation to lactic acid within 48 hrs. The *p*H, of course, was maintained on the acid side with the addition of sterile calcium carbonate. Malt sprouts gave no better result. The importance of liver extract has been previously noticed by Snell, Strong and Peterson[3] in lactic acid fermentation. The optimum temperature of fermentation by *L. bulgaricus* has generally been found to vary from 43° to 50°C. Accordingly, further work is in progress to find out the factor or factors that might be responsible for accelerating this fermentation by *L. bulgaricus* even at 37°C.

Our thanks are due to Dr U. P. Basu for his interest in this work.

N. C. Dey
M. C. Malakar

Bengal Immunity Research Laboratory,
Calcutta, 28-4-1944.

[1] Koser and Felixsaunders, *Bact. Rev.*, 2, 117, 1938.
[2] Pan, Peterson and Johnson, *Ind. Eng. Chem.*, 32, 709, 1940.
[3] Snell, Strong and Peterson, *Biochem. Jour.*, 31, 1789, 1937.
[4] Bhagvat and Sekhon, *Current Science*, 13, 45, 1944.

A NOTE ON THE PRELIMINARY STUDIES ON THE EFFECTS OF X-IRRADIATION UPON GROWTH AND DEVELOPMENT OF JUTE PLANT

The effects of X-rays on seeds and seedlings of various plants have been studied by a number of workers. The results obtained in different cases show contradictory statements and so from these it is not quite possible to make any definite conclusion about the effect of X-rays on seeds and seedlings in general. Several investigators have shown that radiation produces cytogenetic alterations in plants. Koernicke[1, 2], Gager[3], Komuro[4] and Pekarek[5] have shown that as a result of exposure to heavy doses of X-rays the following nuclear changes may take place: striking chromosomal disruptions, clumped, broken or fragmented chromosomes, chromatin bridges between daughter nuclei, nuclear aberrations, etc. In comparison to the large amount of work done on nuclear alteration, very little has been done to show the variation of form and changes in internal structure. Johnson[6] has observed in Sunflower and Tomato, the elongation of cells of the radicle tip, great vacuolation of cells, and absence of nuclei from many cells, increase of xylem at the expense of the pith, greater suberin development in the hypocotyl region, etc. As regards the external features, she has noticed the following changes: fascination in stems, leaves and flowers, abnormality in the shape and size of the leaves, development of many lateral branches thus causing the plant to assume a bushy appearance, abnormalities in flower parts, delay in fruit development, changes in the internal structure of fruits such as, greater development of placenta and an almost total absence of seeds.

The present work was undertaken to study the general external and internal structure and behaviour of Jute plants (*Corchorus capsularis* (D. 154) and *C. olitorius* (Chinsura green) raised from irradiated seeds.

Two sets of experiments were carried on, one with dry seeds and the other with seeds soaked in water for a period of 6 hours. Seeds were treated with different doses of X-rays varying from 202·5 r to 6720 r and three different kinds of rays were given, namely, soft, medium and penetrating in different cases.

A detailed account of the results obtained will be given in a fuller paper to be published elsewhere, but a summary of the results is given as follows. (1) Plants raised from irradiated seeds appear to lose their vitality during early stages of their growth but later on their growth rate becomes enhanced. (2) Some of the irradiated plants show bifurcation of the tip at an early stage of growth and some assume a bushy appearence on account of vigorous lateral branching. (3) Some plants have two or three leaves in one internode in contrast to the normal alternate phyllotaxy of the plant. (4) In some cases delay in flowering caused by irradiation is marked. (5) Amount of woody tissues (xylem) increases due to irradiation. (6) Number of fibre cells appear to be increased in some cases, but the shape and size of the fibres are found to be unchanged. (7) Action of X-rays on moist seeds is more vigorous than that on dry ones.

The present study on the effects of X-rays on Jute seeds both dry and wet show some characteristic changes though none of them is dominant and no particular effect is common to every individual. In our experiments the rate of germination was enhanced in the seeds of *Corchorus capsularis* treated with soft heavy doses and light penetrating doses, but no such effect was observed in those of *C. olitorius*. According to Altman[7] and others, and Koernicke, growth of seedlings became rapid when they were treated with weak doses of X-rays; but I have found that the rate of growth of all the irradiated seedlings was very slow to start with but after a time they revived and began to grow vigorously. Johnson observed changes in the shape and size of the leaves, but no such change has been observed in jute plants.

I take this opportunity of thanking Dr N. Das Gupta of the University College of Science, Calcutta for kindly making arrangements for exposing the seeds to the action of X-rays. The exposures were given in the laboratories of the University College of Science, the Science Association and in the Chittaranjan Sevasadan.

B. C. Kundu.

Botanical Laboratory,
Presidency College,
Calcutta, 1-5-1944.

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ON THE SPONTANEOUS FISSION OF URANIUM

During the course of their investigation on the chemical properties of the so-called "transuranic" elements, Hahn and Strassmann[1] suggested that uranium nucleus breaks up into two parts of comparable sizes, a barium nucleus ($Z=56$) and a krypton nucleus ($Z=36$). The first theoretical interpretation of this observation was given by Meitner and Frisch[2]. According to them the nucleus is like a liquid drop subject to the following forces: (*i*) a short range non-electrical force, only acting between the neighbouring particles; this is proportional to the total number A of the particles in the nucleus, (*ii*) a force analogous to surface tension, also proportional to some power of A and (*iii*) a repulsive coulomb force, proportional to the square of the number of protons Z, and is opposed to the surface force. Just as a drop of liquid, when set into vibration may split into two drops, so might a nucleus. This becomes more probable for heavy nuclei, because of an effective reduction of surface tension, resulting from increasing nuclear charge. The actual nucleus will be stable so long as the sum total of the electrostatic and surface tension energy has a minimum for the spherical shape. With increasing size and charge of the nucleus, this minimum would flatten and would be expected to disappear for some critical value of Z. Nuclei of greater Z would break apart. Bohr and Wheeler[3] have considered the stability of a nucleus (A, Z), against small arbitrary deformations, and have shown that there is a limiting value of $\frac{Z^2}{A}$, beyond which a nucleus is no longer stable with respect to deformations of the simplest type. They show that this ratio is greater by 17 per cent than the value of $\frac{Z^2}{A}$ for U^{238}. Such nuclei are therefore near the limit of stability and it is possible to calculate the potential energy necessary to deform the nucleus sufficiently to produce division. The value

of this deformation potential has been calculated for Th, Pa and U nuclei and they are found to vary between 6·9 (Th^{233}) to 5·0 (U^{235}) MeV. When a neutron is captured by such a nucleus, a compound nucleus in an excited state is formed and if the energy of excitation is greater than the energy of fission E_f, fission will usually occur. The detailed comparison of the calculated probabilities of different U, Pa and Th nuclei lead to good agreement with experimental results. The results obtained so far are based purely upon classical mechanics consideration which is in agreement with the fact that the zero point energy of the nucleus is found to be about 1/15th of the energy of fission E_f. The statistical distribution in size of the fragments of fission depends on the complicated dynamics of the dividing nucleus. The theory is not developed enough to give this distribution, but does indicate that there is a wide range of possible fragments even for energies slightly greater than the critical energy.

Turning to the quantum mechanical aspect of the problem, we have to consider the possibility of the "tunnel effect" which will make it possible for the nucleus to divide even in its ground state by passage through a portion of configuration space where classically the kinetic energy is negative. Bohr and Wheeler have calculated the fission probability λ_f on certain simplifying assumptions which include that the expression (V-E) in the Gamow function is of the order of E_f, *i.e.*, 6 MeV. The mean life is found to be of the order of 10^{22} years. This calculated value is however only approximate.

The nature of the fission products induced by neutron bombardment has been investigated by either chemical or physical methods. In the former method small amounts of chemical elements are introduced as carriers and are then separated by the known analytical methods. The radioactivity of the products are studied with the help of G-M counters. This method gives only the chemical nature (dependent on nuclear charge Z) and not the mass A of the fission products ; the latter must also be radio-active to be detectable. By this method, 80 different kinds of atoms belonging to 23 different elements have been detected.[4] The physical method depends upon the simultaneous determination of the ionisation produced by the two fission products. From the conservation of momentum between the fission products it follows that the kinetic energy of each is inversely proportional to its mass. This method gives the mass and not the nuclear charge of the fission products and can be used to detect both stable and unstable fission products. Jentschke and Prankl[5] have identified the following nuclear fragments produced by predominantly thermal neutrons:

Heavy—Pr, Nd, element 61, Sm, Eu, Gd in the order of decreasing abundance.

Light—Ru, Rh, Pd etc.

Spontaneous Fission Products.—Libby[6] searched for radioactive iodine in a sample of pure uranium nitrate solution kept undisturbed for five years ; he came to the conclusion that the spontaneous fission, if any, must have a half-life period of over 10^{14} years. Experimental evidence for the spontaneous fission of uranium nucleus was first reported by Petrzhak and Flerov[7]. They used as an ionisation chamber, a 15 plate condenser coated with thin layers of U_3O_8 and connected it to a high gain amplifier of extremely high resolution. They found evidence of such fission occurring at a frequency of about six per hour. By means of subsidiary experiments they concluded that the pulses could only be due to spontaneous fission, as their number was too large to be accounted for as being due to atmospheric neutrons. The half life of the U nucleus was calculated to be of the order of 10^{16} years.

One of us by using an essentially similar arrangement, the details of which will be published in the *Transactions of the Bose Research Institute*, has substantially verified the above findings *viz.* that spontaneous fission of U nucleus occur, which are not due to atmospheric neutrons and the average half life is $\sim 3 \times 10^{16}$ years. The ionisation pulses are counted either by a suitably biassed thyratron relay connected with a telephone counter or are recorded photographically on a slowly moving cine-film by a loop oscillograph. An arrangement is being set up for the direct measurement of the energy of the fission products.

If the above conclusion is correct, then in very old minerals rich in uranium, chemical analysis should indicate the presence of stable fission products. Recently, a small quantity of a highly concentrated uranium mineral containing material of orange colour (density 5·64, hardness 3) from some unknown locality in Rajputana came to our hands. It was found to be three times as radioactive as standard U_3O_8, and appears to be a variety of Gummite. The mineral was subjected to usual group separation and the groups to careful spectrographic analysis. The following table gives a partial analysis of the mineral :

UO_3 75%	H_2O 7·25%	PbO 8·26%	SiO_2 &c. 2·23%	ThO_2 0·66%
Rare Earths 0·38%	CaO 1·67%	Na_2O 0·70%	K_2O 1·08%	Gases 0·20%
	Fe_2O_3, 0·20%		Al_2O_3 0·20%	

The lead ratio is 0·1225. The corrected age appears to be about 847 million years. The radium content, calculated from uranium content is about 206 mgms. per ton.

Spectrographic analysis revealed the presence of Ce, Sb, Bi, Sr, Ag, Yt, Yb, Gd, La. Absorption spectra measurements (using the micro-technique of Hopkins), showed the presence of Nd and Pr. Ce was detected by spot-test. It is believed that some of the above elements are fission products.

A comparative chart of elements, formed by fission of uranium nucleus and identified by different methods is given here:

A. Induced fission:

(1) Chemical examination: Radioactive isotopes of

34^{Se}, 35^{Br}, 36^{Kr}, 37^{Rb}, 38^{Sr}, 39^{Yt}, 40^{Zr}, 42^{MO}, 47^{Ag}, 50^{Sn}, 51^{Sb}, 52^{Te}, 57^{I}, 54^{Xe}, 55^{Cs}, 56^{Ba}, 57^{La}.

(2) Physical measurements:

Lighter fragments with masses from 74 to 100, including

34^{Se}, 44^{Ru}, 45^{Rh}, 46^{Pd}

Heavier fragments with masses from 127-162, including 59^{Pr}, 60^{Nd}, element 61, 62^{Sm}, 63^{Eu}, 64^{Gd}.

B. Spontaneous fission:

(3) Chemical examination:

32^{Ge}, 38^{Sr}, 39^{Yt}, 50^{Sn}, 51^{Sb}, 57^{La}, 58^{Ce}, 59^{Pr}, 60^{Nd}, 64^{Gd}, 70^{Yb}.

It is well-known that radioactive minerals are seldom free from rare earths. It is also known that older uranium minerals are richer in rare earths than the young ones, though there is no apparent proportionality between the rare earth and lead content. It is suggested that the growth of some of them is due to the accumulation of fission fragments. The above statement can hardly however, be made very rigorously. For, very complete analyses of uraninites have been made by Hillebrand, Marsh, Hauser and others. Their results show that the abundance of the individual rare earth elements varies widely in minerals of different localities and sometimes occur in large amounts indicating that they form the original constituents of the mineral.

Our expectation that stable fission products should occur in old uraninite minerals can be tested quantitatively in the following way. The amounts of some of the so-called fission products in several such minerals are to be determined chemically. If it is found that in some of the minerals, two or more of the so-called fission elements occur in approximately equivalent weights, then the occurrence can be taken as an indication that they are produced by fission of the uranium nucleus of the same mean life. For such determinations large quantities of uraninite minerals are required; these are at present not available.

The authors are deeply indebted to Dr D. M. Bose, Director, Bose Institute, for his kind interest, helpful suggestions and discussions.

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P. B. SARKAR

Bose Research Institute,
&
University College of Science,
Calcutta, 4-5-1944.

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PHOSPHORESCENCE AFTER GLOW OF SOME ALKALI HALIDES

CRYSTALS of sodium chloride, potassium chloride and potassium bromide are fluorescent under X-ray irradiation. If the period of exposure be sufficiently long these crystals are also discoloured. The discoloured crystals possess extra absorption bands (F-centres). The same centres can also be produced by keeping the crystals in the vapour of the alkali metals at a high temperature. The mechanism suggested for this colouration is as follows: The ionic crystals contain usually a number of vacant lattice points (positive and negative ionic positions) and a number of interstitial atoms frozen in the lattice (in the way of Schottky and Frenkel defects). The photo-electrons released by X-rays execute a sort of Brownian motion before they get trapped in one of the vacant lattice points, formerly occupied by a negative ion. These trapped electrons can be raised to the conduction band by absorption of a suitable radiation and give rise to a new absorption band. To account for the emission we can assume that electrons are primarily raised to the conduction band and thus carried to the neighbourhood of the interstitial ions where additional level systems are present; next transition of electrons to lower levels may occur with the possibility of emission.

The electrons raised to the conduction band in their passage to the radiating centre may get trapped in trapping centres. In ionic crystals the following trapping centres are theoretically possible:—

1. Vacant lattice points (generally negative ionic positions), 2. Tamm's surface levels, 3. Landau's trapping centres. The centres of the type (1) give rise to the F and F′ centres; for the existence of (2) and (3) decisive experimental evidence is not yet available.

It has been observed that the after glow period for crystals of these compounds can be increased to

a great extent by pressure treatment of the samples. For a single crystal of sodium chloride or potassium chloride prepared in the usual way the after glow dies out within half a minute whereas pressed blocks of the same substance could be prepared which retain its after glow for more than 30 minutes (examined visually in a dark room). The colouration produced in these pressed samples also proceeds much more quickly than in single crystals and the intensity of colouration produced is also greater. Besides these, for potassium chloride, it has been further observed that the stability of colouration is dependent on the time of exposure, for example, in the case of 15 minutes' X-ray exposure the colouration produced vanishes within two hours while that produced by exposure of one hour or more appears unchanged even after the lapse of days together.

Now that the samples were prepared by sudden application of pressure we can reasonably expect that the mode of preparation will cause an increased number of interstitial atoms together with a similar increase in the number of vacant positions since sudden application of pressure causes local heating followed by immediate cooling. As the Schottky defect increases the volume of the crystal, this method is not expected to increase the number of Schottky defect. This will account for quicker colouring of the crystals as also the increased intensity of colouration. The duration of after glow is mainly due to the existence of metastable trapping centres whence the electrons can be again sent to the conduction level (and thence to the radiation centre) by the thermal energy of the lattice. The increase in the number of F centres can account for an equal increase in the number of such metastable state (F′ centres), but whether these are sufficient for explaining the 60—100 times increase in the duration of after glow is a matter for further investigation and seems unconvincing at present. Another possibility is the increase in the Tamm's surface levels. The method of preparation obviously increases the lattice defects *viz.*, surface cracks etc. which will cause fresh trapping centres. This alone or together with the former possibility may account for the present observation. The existence of Tamm's levels was also suggested from the experiments of Antonow—Romanowsky[1] who found that for zinc sulphide phosphorus (under ultraviolet radiation) 'α' the decay constant, decreases with a decrease in the particle size.

The after glow is found to die out asymptotically and the duration period is temperature dependent. The decay curve and the exact nature of temperature dependence of 'α' is receiving proper attention; the results will be published in due course.

My thanks are due to Prof. B. B. Ray, D.Sc. for the helpful discussions and for granting facilities for work in his laboratory.

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Calcutta, 4-5-1944.

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E.M.F. DUE TO DIFFERENCE IN TEMPERATURE BETWEEN TWO ELECTRODES DIPPED INTO IONIC SOLUTIONS

Nernst gave a formula for the potential which was produced on dipping a piece of metal into an ionic solution in terms of the solution tension, osmotic pressure and temperature of the solutions. So far as we are aware there is no data for the E.M.F. which is produced when two electrodes of the same metal are dipped into a homogeneous ionic solution and one electrode is maintained at a higher temperature with respect to the other.

Two copper electrodes through which vapour from boiling liquids can be passed were electroplated with copper in the same bath and introduced from either side to a vertical glass tube containing the solution. To avoid convection difficulty the electrode introduced at the top of the glass tube was maintained at higher temperature and the other at the bottom at room temperature. The top electrode was maintained at different temperatures by passing vapour of boiling water (100°C), benzene (80·2°C), acetone (56·5°C), the other electrode being throughout maintained at 33°C,—the room temperature. The E. M. F. produced at various temperature differences were measured by means of a calibrated potentiometer.

Temperature Difference between the two Electrodes and E. M. F. Produced.

Temperature difference ...	67°C	47·2°C	23·5°C
E. M. F. produced for N/2 NaCl Soln. in millivolt ...	60·1	31·3	13·0
E. M. F. produced for N/8 Cu_2SO_4 Soln. in millivolt ...	73·0	42·7	17·6

Experimental improvements have lately been made with electrical heating arrangement and other various experimental difficulties have also been met with. The E.M.F. produced have been observed with NaCl, $CuSO_4$, KCl, KBr, $CuCl_2$ solution and the E.M.F. is found to increase gradually if the solution is gradually diluted, the temperature differences between the two electrodes being maintained constant. The

electrodes at the lower temperature is found to be at a higher potential with respect to the hot electrode in the case of NaCl solution and reverse happens in the case of $CuSO_4$ solution. It has however been observed that if the two electrodes are maintained at the same temperature and the solution near the top electrode is locally diluted, the E.M.F. produced is just in the opposite direction of what is obtained by heating the upper electrode.

My thanks are due to Prof. B. B. Ray, D.Sc., Calcutta University for granting me facilities to work in his laboratory.

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THE EFFECT OF LIGHT ON THE SYNTHESIS OF ASCORBIC ACID BY GERMINATING SEEDS

It has been observed that dry seeds of soya-bean contain practically no measurable quantity of ascorbic acid, as determined by titration with the indophenol reagent. But during germination in absence of light they begin to accumulate ascorbic acid within two or three days from the start. This accumulation reaches a maximum on the 5th or 6th day of germination and thereafter begins to decline, keeping to a lower but approximately constant value. It has been found that this biosynthesis can be accelerated when the seeds after germination for one day in the dark are exposed to direct sun-light for a definite period each day. Some mean values of ascorbic acid content during germination of soya-bean are given below :—

Ascorbic Acid content in mg. per cent on wet basis of the germinating Soya-bean

Germination in	Ascorbic acid on the day of germination									
	1st	2nd	8rd	4th	5th	6 h	7th	8th	9th	10th
Darkness	nil	1.5	10.4	14.8	17.3	17.8	14.0	12.0	7.0	7.0
Sun-light	nil	5.2	17.9	27.7	34.7	80.6	30.0	30.4	80.2	80.0

This work was carried out during December, 1943.

Our thanks are due to Prof. B. C. Guha for his kind interest in the work.

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Department of Applied Chemistry,
University College of Science & Technology,
Calcutta, 7-5-1944.

PHOTOBIOSYNTHESIS OF ASCORBIC ACID (?) BY GERMINATING SEEDS

The formation of ascorbic acid, as determined by indophenol titration, during germination of seeds and the stimulating effect of light on this process have been reported by us[1] and also by others. It has been assumed by all these investigators that the reducing substance formed in the presence of light, as determined by the usual method of titration with 2:6-dichlorophenol indophenol, is identical with ascorbic acid. In order to test this assumption experiments have been carried out with soya-bean and *Kancha Mung* (*Phaseolus Mungo*) germinating in the dark under properly controlled conditions of temperature, moisture etc. and exposing them to sun-light and ultra-violet rays of known wave-lengths for a definite period and then testing them both titrimetrically and biologically. It has been observed that an indophenol reducing substance accumulates during germination in the dark and increases to a considerably higher value when the seedlings are exposed for a period to direct sunlight or ultra violet rays of wave-lengths between 3000-4000 Å. Some of the mean values are given below :—

Indophenol reducing equivalent in terms of Ascorbic Acid in mg.% (dry basis) of germinating seeds under various conditions

Seeds	Kept at 29-30° C. for 6 hrs. in	Exposed for 6 hrs. at 29-30° C to	
	Dark	Sunlight	Ultra-violet bet. 3000-4000 Å
Soyabean ..	23	40	39
Kancha Mung	55	80·5	80

Preliminary results from bio-assay with guinea-pigs seem to indicate, however, that the substance produced in the germinating seeds under stimulation of sun light or ultra-violet light, is not identical with ascorbic acid, though it gives indophenol-reducing action. The reducing substance formed during germination in the dark is, however, mostly, if not wholly, ascorbic acid as previously shown by Ghosh and Guha.[2]

Experiments for further confirmation are in progress.

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"Science can afford to wait but Swaraj cannot." -P. C. Ray.

"Her (India's) elevation will not come in Sir Prafulla Chandra Ray's time. A small, spare man, in feeble health, and a confirmed dyspeptic, he will be spent in her service. But the memory of these services will survive."

—SIR T. E. THORPE, *Nature*, March 6, 1919.

Photo by courtesy
Amrita Bazar Patrika

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In Memoriam :

PRAFULLA CHANDRA RAY

BORN: AUGUST 2, 1861. DIED: JUNE 16, 1944.

SIR P. C. RAY, more familiar to his countrymen as ACHARYA PRAFULLA CHANDRA RAY, is no more. He passed away after a short span of illness on Friday, the 16th June at 6-27 P.M. in his own room at the University College of Science and Technology, Calcutta, which was his home for the last 30 years of his life. With him has been severed the last link of the towering personalities of the last generation, who have made Bengal what it is to-day, culturally and intellectually, and who, by general consensus of opinion, stand in the front rank of the Makers of Modern India.

The outstanding feature of his greatness was that he loved his people and was one of them. He never thought of keeping himself above and aloof from the common man. His was a soul that disliked to dwell apart from others. He abhorred the selfish enjoyment of his own greatness, but wanted to share his feelings with all around him —great and small, rich and poor, learned and illiterate. More at home with people in humbler walks of life he used rather to say that he was afraid of great men—men of power, position, wealth and honour. In fact, he did not know how to become great in the modern sense of the word. For, though placed in power he never exercised it, holding a very high position he never felt it, possessed of wealth he never kept it, adorned with honour he could never be induced to enjoy it. Such was his greatness—a rarity by itself, which avoided all taints of vanity, scrupulously shunned all attempts to make a good impression or favourable appearance, and expressed a strong dislike for aristocratic isolation.

Though a chemist by choice, his activities were never confined within the four walls of his laboratory; and his life was far from that of a brooding scientist with an

uneventful routine of study, laboratory and rest. Within a frail and fragile frame he nurtured a virile and sympathetic spirit whose activities were many-sided and embraced almost all spheres of human interest. Intellectual, scientific and industrial regeneration, social reform, economic freedom and political advancement of this country, all made equally strong appeal to him and absorbed as much of his time and service as did his scientific researches and teaching. Above all, in times of distress and suffering, he was the first man in Bengal to respond to the call of humanity—be it a famine, a flood or any other natural visitation. Of him it may be truly said in the words of Emerson, his favourite philosopher, that he was "in this world not to get but to give; not for prosperity but to suffer for the benefit of others like the noble rock-maple tree which in all the villages bleeds for the service of man". His life was one of pure self-immolation that could give all and take nothing, and even receive nothing.

A friend of the poor and lowly he gave away abundantly in charity, often unnoticed and unknown to others, though he never had a large income of his own. His riches, however, consisted in the fewness of his wants as he lived a single and ascetic life of Spartan simplicity. In him were harmoniously blended the lofty ideals of ancient oriental culture with the dynamic and progressive aims of the modern rationalistic western civilization.

Born in a cultured and rich family, his father being a landed proprietor with liberal western education, PRAFULLA CHANDRA imbibed from his very childhood through the latter's influence the principles of rational thinking and the value of disciplinary methods. After his first education in his father's village school up to the age of nine when the family migrated to Calcutta, he joined the Hare School and subsequently the Albert School from which later he passed the Entrance Examination in 1879. During this period a persistent attack of dysentery so shattered his health as to leave a permanent stamp of weakness upon his constitution. He then joined the Metropolitan Institution, now known as Vidyasagar College and also attended lectures on Physics and Chemistry at the Presidency College. The lectures and experiments of Prof. Pedler, at the latter institution stirred his imagination and awakened in him a spirit of enquiry and interest for natural science. In 1882, he prepared for the Gilchrist Scholarship Examination—an All-India Competition—without the knowledge of his friends and relations and was able to secure one scholarship, the other successful competitor being a Parsi gentleman, Bahadurji. This success paved the way to fulfil his long-cherished desire for higher studies in Europe, for at this period there was a serious set-back to his family fortune due to his father running into heavy debts. He joined the University of Edinburgh in 1882 in the Faculty of Science. In Chemistry he came under the influence of Prof. Crum Brown and it became his favourite subject. Alexander Smith

and James Walker were his class-fellows. In 1888 he obtained his D.Sc. degree on a thesis in Inorganic Chemistry and became the recipient of several scholarships in the University.

After return to India he was appointed in 1889 Assistant Professor of Chemistry at the Presidency College, Calcutta, where in 1911, a few years before retirement, he became its Senior Professor. Here, in addition to his teaching work, he devoted himself with great enthusiasm to the pursuit of original researches. His colleague, late Sir Jagadis Chandra Bose, in Physics and he in Chemistry were the first Indian teachers to initiate research work in natural science and to inspire young minds with a spirit of enquiry, desire for knowledge and love of truth. Soon he established his reputation as a teacher of exceptional ability and his lectures wielded a great influence upon his students, illustrated as they were not only by numerous experiments but enlivened as well by his original wit, humour, examples from daily life and notably by attractive accounts from the lives of the great masters of science. His animating account of the pilgrimage of Wöhler from Germany to the great Swedish savant Berzelius, where Anna, the kichen maid, served as a laboratory assistant, still rings in many ears. Students from other sections, both of science and arts, were attracted by his lectures and the lecture gallery was always full to the brim. Soon a body of ardent research workers gathered round him forming the nucleus of an Indian School of Chemistry. It is, therefore, no wonder that most of the eminent chemists of India to-day had their first lessons from him. In 1916 he retired from the Government service to join the University College of Science, then newly started, as Palit Professor of Chemistry at the request of that great educationist, the late Sir Asutosh Mookerjee. Here, in a more congenial and free atmosphere his research activities increased manifold and the band of devoted workers continually swelled in numbers. The total number of original papers published from his laboratories at the Presidency College and the University College on a large variety of chemical problems is likely to approach a couple of hundreds. In 1902 he published the first volume of his monumental work, the 'History of Hindu Chemistry' which was followed by the second volume in 1908. The work represents the result of a long and painstaking research extending over 15 years and gives us a glimpse into the achievements of the early Hindus in the domain of positive science. The book was acclaimed by competent critics and judges all over the scientific world as a valuable contribution to the history of science.

Far outweighing his reputation as a teacher and researcher, his service as the founder of a School of Chemistry will ever remain as a conspicuous landmark in the history of our national progress. The inauguration of the Indian Chemical Society in 1924, of which he was the Founder President for the first two terms, constitutes another

instance of his signal service in this line. The Society was started with a handsome donation of Rs. 12,000 from him towards its building fund.

In 1936 he retired from his position as Palit Professor of Chemistry and remained as an Emeritus Professor to the end. Long before this, at the completion of his 60th year in 1921, he wrote to the authorities of the University making a free gift of his salary from that date onward till his retirement. It was also suggested that the money accumulated thereby should be spent for further extension and development of the Department of Chemistry in the University College of Science and Technology. The University has already created two Sir P. C. Ray Research Fellowships in Chemistry to be maintained from the interests of this fund (Rs. 1,30,700). Further, an endowment of Rs. 12,000 was made in 1922 for an annual Research Prize in Chemistry, named Nagarjun Prize after his suggestion. This was followed by a second endowment of Rs. 11,000 in 1936 for a research prize in Zoology and Botany, named as Sir Asutosh Mookerjee Prize.

As a man and as a teacher his relation with his pupils was always very warm and affectionate, transcending the mere natural admiration and respect from the taught and good wishes from the teacher. There was nothing in his private or public life which was not disclosed to his pupils who regarded him as their friend, philosopher and guide. He maintained in its fullest sense the tradition of the ancient Indian Gurus with his charity extended beyond the circle of his pupils to the student community in general and to the maintenance of many schools and colleges in Bengal.

He was sent on deputation to Europe in 1904 by the Government of Bengal. In 1912 he visited England again as a representative of the Calcutta University to the Empire University Congress, and in the same year the Honorary Degree of D.Sc. was conferred on him by the University of Durham. He was also the recipient of similar Honorary Degrees from the Universities of Calcutta, Dacca and Benares. He was made a Companion of the Order of the Indian Empire in 1911 and was knighted after the last World War. In 1920 he was elected General President of the Indian Science Congress. In 1934 he was elected an Honorary Fellow of the London Chemical Society and also that of Deutsche Akademie, München, a little earlier.

At or about 1900, PRAFULLA CHANDRA founded the Bengal Chemical and Pharmaceutical Works which was converted into a limited concern in 1902, when he made a gift of his shares forming a Board of Trustees for conducting a school and promoting other benevolent activities in his native village in the district of Khulna. The Bengal Chemical and Pharmaceutical Works, now so well-known all over India, will ever remain as a glorious legacy to his countrymen and as a standing monument to his memory. He was also connected with a large number of limited companies, such as cotton mills, sugar works, chemical industries, pottery and porcelain industries, book

companies, etc., either as a Director, Promoter or Patron. Almost every industrial enterprise in Bengal had his blessings and encouragement. He never ceased to urge the Bengali youths to take to business and industries, following the example of their hard-working brethren from Marwar. The pre-eminence of Bombay and the activities of Parsis and Gujaratis in this respect were frequently referred to and stressed upon by him. No terms were considered too strong by him with which to condemn the indolence and ease of the Bengalee youths and their insane craze for university degrees.

In 1929 when the whole country was in a state of convulsion due to the Non-Co-operation Movement led by Mahatma Gandhi, he threw himself heart and soul into its constructive and economic programme. The great pioneer of chemical industries became an ardent advocate of spinning and weaving as a means of ameliorating the appalling poverty in the Indian villages. He himself took to spinning—a practice which he religiously kept up till failing vision intervened. He himself never used anything but Khadi till the end of his life. People often used to call him 'a saint of Science and an apostle of khadi'. A number of his shares in the Bengal Chemical and Pharmaceutical Works, Ltd. (face value Rs. 17,000, at present valued at Rs. 70,000) was made over by him to a Trust in order that the profit therefrom might be utilized for the benefit of poor widows, orphans, as well as for handspinning and production of Khadi.

His services to the country as a social reformer are outstanding. Long before the Congress Movement against untouchability was initiated by Mahatma Gandhi, PRAFULLA CHANDRA by his writings and speeches uncompromisingly fought against this and many other social evils like caste system, child marriage, dowry system, communalism and orthodoxy in general. In caustic, sarcastic and almost vitriolic terms he never ceased to cast his severe strictures upon our decayed and diseased social system which exercises such a baneful effect upon individual and national progress. As early as 1917 he presided over the Indian National Social Conference in Calcutta and exhorted the people to unite and do away with untouchability, as India divided within itself could never attain independence. He was an ardent advocate of Hindu-Muslim unity and the fusion of all communities into one great Indian nation.

As a philanthropist PRAFULLA CHANDRA was ever ready to come to the rescue of suffering humanity. Whenever he appealed for funds, as in the case of Khulna famine (1921) and North-Bengal flood (1922), money came simply pouring in from all parts of India for people had an abiding confidence in him.

In politics, though never actively on the field, he belonged to the advanced school. His well-known remark on a memorable occasion, "Science can afford to wait but Swaraj cannot", gives a measure of his patriotism.

Though a scientist by profession, his love for, and knowledge of, literature and history were much above the average. Rabindranath, Madhusudhan Dutt and

Shakespeare were his favourite poets from which he could quote off-hand from memory at any time. He was also very fond of the works of Emerson and Carlyle. His interest in literature and history was so great that he was often heard to say that he became a chemist by pure accident. In 1932 the first volume of his autobiography "Life and Experiences of a Bengali Chemist" was published. It was dedicated to the youth of India with the hope of stimulating their activities. The second volume of this work was issued a few years later (1935). An idea about the value of the book is best derived from what Prof. Armstrong wrote about it in *Nature*:—

"From beginning to end the message of the book is one of the highest endeavour—pulsating with vitality and intellectual force."

As an educationist he strongly supported the use of the mother tongue as the medium of instructions, without which originality and the habit of independent thinking can never be developed, nor the standard of efficiency in our schools and colleges be raised.

On the completion of his 70th birth-day the Indian Chemical Society presented him a Commemoration Volume which contained contributions from many eminent chemists of India and Europe. A similar Commemoration Volume and an address, on behalf of the Public of Bengal, was presented to him on the same occasion. His 80th birth-day also was celebrated by the public when he received a large number of congratulatory addresses from the Calcutta University and various other educational institutions as well as from many industrial and scientific organizations.

A saint of science, a patriot, a philanthropist and a nation-builder has passed away; a truly noble soul, a kind and compassionate figure has disappeared from our midst. But PRAFULLA CHANDRA was greater than his life or work and has left behind a pattern of character for us and more specially for the student world as pointed out by Gandhiji and so aptly and beautifully delineated some time ago by Rabindranath while presiding over his 70th birth-day celebration:

"It is stated in the *Upanishads* that One said 'I shall be Many'. The beginning of creation is a move towards self-immolation. ACHARYA PRAFULLA CHANDRA has become many in his students and has made his heart alive in the hearts of many. And that could not have been at all possible had he not unreservedly made a gift of himself. The power of creation having its inception in self-sacrifice is a divine power. The glory of this power in the ACHARYA will never be worn out by decrepitude. It will extend further in time through the ever growing intelligence of youthful hearts; by steady perseverance they will win new treasures of knowledge."

He came with a great mission to serve his country and has left an imperishable example, which will serve as a light and inspiration to the present and future generations.

DEPARTMENT OF PLANNING AND DEVELOPMENT

THE recent Government of India *communiqué* announcing the creation of a new Department of Planning and Development and the appointment of Sir Ardeshir Dalal to the new port-folio have evoked widespread comments in the public press. It is possible to have a realistic outlook to the announcement. The action of the Government may at least be regarded as a "gesture admitting a tiny ray of hope in these days of bleak despondency". It is to be noticed that the Government have not declared its objective in taking the new step, but the very fact that they have offered the port-folio to one of the signatories of the Bombay Plan may be taken to show, as Sir Ardeshir has pointed out, that they have perhaps a certain amount of sympathy with the declared objective of the Bombay Plan *viz.*, the raising of the standard of living for the common man of India by a process of planned expansions in industry, agriculture, communications, and other nation building activities, perhaps in so far as that is compatible with the interests of Imperialism. A national government would not have hesitated to declare its 'objective' and such a declaration would have been hailed with acclamation by all sections of the people. Probably the Department would have been called the department of "National Planning and Development", a step we have long been advocating. But we have probably no right to expect such large promises from a government of foreign bureaucrats, and after our experience of large promises in the past, generally followed by vague excuses, or studied silence, it is better to start with no promises but reserve judgment on actual achievement.

As the newly appointed Member himself admitted in a press statement, full measures of national planning and development are possible only under a national government. We would go further, and would have no hesitation in proclaiming our firm belief that India is in urgent need of *inspiration for a national purpose,* and would respond to trusted and inspired leadership with a quickness which will surprise the world, just as the transformation of Soviet Russia from medieval feudalism to the highest form of technological civilization has surprised friends and foes alike. Such leadership can only come from national leaders like Pandit Jawaharlal Nehru and others still in confinement. Under the present system, we think that the new Member will have many hurdles to overcome and he may not have the requisite co-operation of his colleagues in the Viceroy's Cabinet or of the officials. The course for the new Member is, therefore, likely to be neither smooth, nor promising. But like a Stein, he may have tact, and foresight enough to overcome these difficulties and lead the nation on the way to prosperity and a new life. It is in this hope that we welcome the creation of the Department and the appointment of Sir Ardeshir Dalal as its head.

But even the most gifted of men having the greatest freedom of action, and plenty of finances at his disposal cannot achieve anything substantial unless he has a suitable administrative machinery to assist him in his work, and gets the assistance of willing officials, or the co-operation of an efficient brain-trust composed of persons who will not be guided by motives of self-interest. We do not think that such a machinery exists at the present moment, but with a certain amount of reshuffling of the existing organizations, and a radically new policy in handling them, substantial progress towards the goal can be made. Prof. A. V. Hill, in his illuminating address to the Indian Science Congress at Delhi this year gave us a lucid picture of the British system, defining the fundamental principles which should be the same at every latitude and Sir J. C. Ghosh and his colleagues of the National Institute of Sciences have given their own suggestions on this subject at the symposium held by the National Institute of Sciences at Calcutta and Delhi. We consider that if the new Department is to justify the hopes aroused, it cannot ignore the existing deficiencies in organization, or the faultiness of the principles now pursued which we have criticized so frequently in these columns. It should be guided by the principles enunciated in Hill's article, and in the resolution of the National Institute of Sciences. Based on these, the following suggestions are made:

The first suggestion is that all the scientific research organizations and research institutes under the Central Government should come under the new Department. The present position is very anomalous, as these organizations are now scattered over several departments of the Central Government, and the control exercised varies from a loose, undefined connection to the fullest measures exacted by a bureaucratic system primarily devoted to interests other than national. For example:

Geological Survey: is under the Department of Labour. What 'Labour' has to do with geology is probably difficult to see for anybody.

Meteorology: is under Posts and Air but meteorological information is needed by all sections of people.

Scientific and Industrial Research: still a baby amongst scientific departments was first under the Department of Commerce but is now under the Council, a registered body of Government officials, and some representatives of science and industry nominated by the Government, and presided over by the Hon'ble Member in charge of Industries and Civil Supplies.

Medical and Agricultural Research: under two registered and semi-autonomous bodies having very cumbrous composition *viz.*, the Indian Research Fund Association and the Imperial Council of Agricultural Research are under the Chairmanship of the Hon'ble Member for E.H.L. (Department of Education, Health and Lands). The corresponding research institutes in these two subjects are, curiously enough, under the fullest bureaucratic control of the E.H.L.

Botanical and Zoological Surveys, the Survey of India: are under the E.H.L.

It will thus be seen that the existing scientific departments of the Central Government are dispersed under different Hon'ble Members of the Viceroy's Cabinet, most of them having many other serious duties and pre-occupations, and probably none of the Hon'ble Members or his secretaries being selected on account of his previous knowledge of the sciences he has to deal with, or having gained by his part played as a politician or administrator even the most casual placed under his control or even having any sympathy with its working. The amount of control exercised varies as we have pointed from the maximum measure allowed by the bureaucratic code to a varying degree of looseness, but the essential threads are always in the safehands of I.C.S. secretaries and bureaucrats who are always changing from one department to another for their, the Government's or somebody else's convenience; they* are seldom kept attached to the same department long enough to acquire sympathy with the department or proficiency in its handling. It is obvious that under such a hodgepodge system, no Central plan can be, or has been evolved for national development. The Hon'ble Members and their secretaries have been content merely to carry on, and have hardly shown any initiative, nay in certain cases, they have allowed the departments to fall into decay.

For example, the Botanical and Zoological Surveys of India, which have in the past done important work have been financially starved and depleted of officers for a number of years. On account of dearth of officers, and lack of funds, field work in these two subjects has been entirely stopped. They afford examples as to how important scientific activities can be starved under a department, with little or no interest in them. The Geological Survey is still active, and has been doing good work, but it is quite inadequately staffed for the enormous task it has still to accomplish.

Probably it has never occurred to the Hon'ble Members in charge of these surveys how important they are for the development of the country's resources. They have probably never heard how Soviet Russia mobilized 10,000 geologists, and were able to discover enormous resources in petroleum, coal, iron, and other minerals—development of which by the national research institutes has enabled Soviet Russia to defeat the German onslaught. Probably they have never heard of the epic work of the Russian plant collectors who at the end of the last War, collected plant specimens from all over Soviet Russia, South America and other parts of the world, and with the aid of supplementary laboratory researches developed new kinds of wheat, potatoes, fruits and other food crops congenial to the Russian soil and thus could maintain Russia's food-front at full-strength even during the present Global War.

If the Hon'ble Members had the slightest notion of the enormous potentialities of the surveys under them, they would not have allowed these to decay, as they have done.

Such neglect of science has occurred in other countries, but being forewarned, they have taken ample measures in advance. It has been found necessary in almost all countries to place all scientific departments, surveys and research institutes necessary for the development of the country's resources, industries and agriculture and for the ensurance of public health under one responsible member of the Central Government, and in course of the current war, the existing anachronisms have been ruthlessly wiped out. In the U.K., he is called the Lord President of the Council. He has no ordinary department under

* In India, a civil servant may be to-day a district officer, next year an assistant secretary in the E. H. L., next year he may be attached to the food department, then he may be a sugar controller, and ultimately may revert back as Commissioner for a division. It is quite unlike the way the civil servants are utilized in England. There they are attached to a particular department, say, currency, trade, or diplomatic service, and are allowed to have sufficient time and opportunity to gain expert knowledge of his subject. Even then, they have been found slow, evasive, and generally without any spirit of initiative, and as far as scientific departments are concerned, they have been replaced by professional scientists in all key-positions. It is completely overlooked in this country that we are living in a scientific-technical civilisation. Most departments of Government in these days have to deal primarily with matters requiring the knowledge of science and technology. But people in authority are more often than not quite innocent of such knowledge. Is it any wonder that under such conditions perfect chaos prevails?

him, and can devote all his time for planning and reconstruction. Usually public men having acquaintance with ***science and industry*** have been selected for this highly important post. During the last war, the post was held by the Earl of Balfour, himself an amateur scientist and an intimate friend of many scientists and a lover of science, and during the present war it has been held from 1940-1943 by Sir John Anderson who, though a civil servant, is a Ph.D. in Chemistry, and has wide acquaintance with science. The post is now held by Lord Woolton, an industrialist, and lately food minister. The practice of putting civil servants at the head of administration in scientific departments has been given up, and scientists of established reputation, and sometimes not having much experience of administration have been called up straight from their laboratories to take charge of the administration of the departments, with great success.

It may be objected that the effect of removing research from the direct control of the various departments under which it is now placed would cause some harm to the work of those departments. There is hardly any logic in such arguments as the scientific sections appear to have been attached to departments without any rhyme or reason, *e.g.*, Geological Survey to Labour. But though a temporary disturbance may be caused, the final result would be that research would be done in a far better manner, that the various branches of research would be brought into closer co-operation with one another, that gaps and weaknesses now apparent would be made good, and the Hon'ble Members and their secretaries would be relieved of a charge, which, as far as our information goes, they find rather boring.

It is not realized in this country that research cannot be tied up too directly to the solution of immediate practical problems; and those who were responsible, in the Departments, for tackling the practical problems, *e.g.*, the Public Health Commissioner, are not, in general, research men, but executive officers who would be enabled, by *ex-officio* membership of the various Boards and Committees, or by contact with the various Directors of Research, to obtain the scientific information they require and to give practical bias to the directions in which research would be undertaken.

When the National Institute for Medical Research in England was started in 1914, with Sir Walter Fletcher, F.R.S. as Secretary, there was a proposal to put it under the Ministry of Health; but Fletcher opposed the idea and had his own way, and it was placed under the Medical Research Council, under the Lord President. Nobody now doubts the wisdom of the step. The same practice is followed in the other research organizations. Nobody would think of putting the National Physical Laboratory under the Board of Trade, the Geological Survey under the Ministry of Fuel and Power, the Food Investigation Board and its Laboratories under the Ministry of Food, the Radio Research Board and its establishments under the Post Office, or the Building Research Station under the Ministry of Town and Country Planning. There was a suggestion to put the Agricultural Research Council under the Ministry of Agriculture and Fisheries, but a much better solution was arrived at by setting up an Agricultural Improvement Council in that Ministry. It is difficult to see why the same general principle of bringing research under a single separate organization and of leaving the Departments to make their own arrangements for applying the results of research to the practical problems they have to face should not apply to India, by the creation of Development Boards which will consist of representatives of the Department of Planning and Development on the one hand and those of the relevant Departments on the other hand, as has been suggested by the National Institute of Sciences of India.

As a logical sequel to our first suggestion, we would propose that the scientific departments under the Hon'ble Member for Planning and Development should be constituted into the following boards:

(1) Surveys of Natural Resources.
(2) Scientific and Industrial Research.
(3) Agricultural (including Animal Husbandry) Research.
(4) Medical and Public Health Research.
(5) Engineering (to deal with irrigation, soil river surveys for hydro-electric power generation, soil conservation, etc.). Other boards may be added if necessary.

Each Board should have, as Chairman, an eminent person, either a non-official scientist or a professional man in the field concerned. The members of the Board should be eminent and experienced scientific and professional men in their own fields. The executive work of each Board should be in the hands of an eminent scientific man. He should have direct access to the Hon'ble Member, and should be given the status of a Joint or additional Secretary of a department of the Government of India. Each Board should work through Research Committees.

Our next suggestion is that the Hon'ble Member for Planning and Development should try to secure the co-operation of all non-official scientific talents available in this country (formation of a brain trust) and should try to foster the growth and development of such talents at the source by a liberal system of research grants and research scholarships to the universities and other research institutes, and should

help to build permanent research schools on specialized lines in the universities (training of scientific and technical personnel).

In India unfortunately there exists a fundamental antagonism between the official and the non-official, the individual and the Government. Unofficial science has been, before the establishment of the B. S. I. R., I. C. A. R., largely ignored and neglected by the Government, and promising schools of research, under distinguished scientists, were allowed to fall into decay on account of lack of financial support.

This is very unfortunate, as unofficial science of a country and fundamental researches are the backbone of all its scientific work. The National Institute of Sciences, in its Delhi session at the beginning of this year, made some suggestions which can be summarized as follows: —

(1) That the unofficial scientists of India have little means of making their views heard and respected by the Government of India.

(2) That the large number of Academies and scientific societies which have been founded by Indian men of science and above all the National Institute of Sciences which is the most representative body of senior scientists are not usually consulted by the Government of India, and are not represented by their own right in advisory councils, or other bodies of scientific experts which are frequently appointed by the Government.

(3) That the total expenditure on scientific research in this country is extremely meagre. The National Institute of Sciences recommended that 10 per cent of the national income amounting to 5 to 6 crores of rupees should be spent annually on researches of all types, surveys, maintenance of research schools and institutes, etc.

We do not know whether the Government of India will agree to the suggestion of the N. I. S. to form a National Research Council on the American model which is equivalent to handing over a large amount of planning for research and of organizing research work to a non-official body of scientists. The proposals are neither impracticable nor utopian. As a matter of fact, the system is being actually followed with great success in the U. S. A., Japan and Canada, though in the last two countries there is much more of official representation than in the U. S. A. But the points of the N. I. S. can be met to some extent and should be met, if the organization of the new Department of Planning and Development is carried out on the lines suggested above. The adoption of the proper organization and proper guiding principles right at the formative stage can alone ensure the effectiveness of the new Department.

Our third suggestion is that proposals for establishment of national scientific laboratories and research institutes should not be allowed to be put in cold storage on the usual plea *"that may stand till the war is over"*. This attitude, under which the Hon'ble Members have taken shelter to cover their own inefficiency and lack of enthusiasm for positive work, is prompted by the idea that the problems of the war can be separated from those of peace, that the wants and needs of the civil population have to be completely sacrificed to military exigencies. This attitude is diametrically opposed to that followed in England and other belligerent countries where the whole population, whether actually engaged in war-work or not has to be regarded as combatants. The attitude of the Indian rulers has led to such disasters as the Great Bengal Famine of 1943, the 360 per cent rise in prices, and may lead to further disasters if not corrected in time.

Here in India, we have been talking of National Physical, Chemical, Fuel, Metallurgical Laboratories, of a Glass and Silicate Research Institute for the past three years, and the talks have hardly taken us to a report stage. Nobody knows when these important laboratories will come into existence; meanwhile commercial missions camouflaged as scientific are imported to help India out of the chaos. Contrast with this the stand taken by Canada and Australia. When the war broke out, Australia was not manufacturing a *Chhatak* of glass not to speak of optical glass; but the rulers of Australia realized that glass, particularly optical glass, was a vital war-necessity, and the Australian Department of Scientific and Industrial Research mobilized all the available scientific and technical personnel, and aided by experts lent from England, started manufacturing optical glass within 14 months of the date when the project was launched. Now she is manufacturing all her peace and war time needs in glass. The Canadian Government started a Research Enterprise Ltd. under the National Canadian Council of Research, which have been able to complete plants for the manufacture of many essential commodities for which Canada had to depend formerly on U. S. A. and the U. K.

Why turn to Australia or Canada? Even in India, huge scientific laboratories in Physics, Chemistry, and Engineering complete with equipment, apparatus and workshops have been built in Cawnpore to deal with military problems in course of the last two years.

Nay, the conclusion is inevitable that the Hon'ble Members and the secretaries in charge of the scientific departments have shown little interests in the work of the research organizations under their control, and have allowed things to remain as they were. The 'cold storage' policy is a standing monument to the defects of the existing organization.

POST-WAR EDUCATIONAL SCHEME FOR INDIA

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THE magnitude of the problem of educational reconstruction in a country with 85 per cent of the population still illiterate need hardly be overemphasized. The present system of education obtaining in India is hopelessly inadequate, disproportionately top-heavy and grossly wasteful of the nation's time, money and energy and does not satisfy even the very minimum educational needs as accepted in every civilized country. The weakness and insufficiency of her educational system have left their mark in every sphere of her activities, social, economic and political and have caused a permanent stumbling block in her progress. The solution of her problem of educational reconstruction, colossal as it is, requires, therefore, a careful and thorough planning, the execution of which will require so much money that it will frighten the Government and so much time that it will discourage even the most ardent and enthusiastic educationists and national leaders of the country. And yet these are the two fundamental requirements of the scheme for post-war educational development in India, envisaged in the report of the Central Advisory Board of Education, recently submitted to the Reconstruction Committee of the Viceroy's Executive Council. The scheme would require for its execution, as the estimate goes, an annual expenditure of Rs. 312·6 crores, when in full working order, of which the Government would be required to spend Rs. 277 crores, and a period of 40 years before the whole plan will be in action. But it should be borne in mind that in planning for such a national system of education, 'the Board's object throughout has not been to plan an ideal system of public instruction but rather to lay down the very minimum necessary to place India on an approximate level with other civilized communities.' As to the period of operation of the scheme, there is hardly any escape from this, as it is entirely a problem of building anew. The problem of education in India is not one of building on the existing structure, because, as the Board has rightly diagnosed, 'the present system does not provide the foundations on which an effective structure could be erected', and 'much of the present rambling edifice will have to be scrapped in order that something better may be substituted.'

While the Central Advisory Board's scheme for post-war educational development in this country is not certainly above criticism, and there may be disagreement on minor details and issues, the general principles and the main educational structure laid down in the scheme will doubtless be found acceptable to all sections of Indian people, vitally interested in the educational uplift of the country. The problems and the proposed measures for reform have been discussed in the report under the following items, *viz.*, (1) Basic (Primary and Middle) Education; (2) Pre-Primary Education; (3) High School Education; (4) University Education; (5) Technical, Commercial and Art Education; (6) Adult Education; (7) the Training of Teachers; (8) the Health of the School Child; (9) the Education of the Handicapped; (10) Recreative and Social Activities; (11) Employment Bureaus and (12) Administration.

The purpose of this article is to present to the reader the different stages of education contemplated in the scheme, through which the future children of the land should pass as they grow to manhood before they are in a position to enter professions suited to their training and attainments. The problems of adult education, the training of teachers, the health of the school children, recreative and social activities, etc., will not, however, be included within the scope of the present discussion for which the original report may be consulted.

The different stages of education will be best understood with reference to the adjoining chart (Fig. 1) prepared by the writer, which, although not complete in all respects, indicates sufficiently clearly the main features of the proposed stages.

PRE-PRIMARY EDUCATION (NURSERY SCHOOLS AND CLASSES).

The need for pre-primary education in this country has not been sufficiently realized, as is clearly evidenced from the utter lack of provision for the same in the present educational system. An efficient national system of education cannot afford to do without a liberal provision for pre-primary education to prepare children for compulsory basic education. Since the Board has recommended universal and compulsory education for all boys and girls between the ages of six and fourteen, pre-primary education refers to the education of children who have not attained the compulsory school age of six. The education during these formative years of the growing child should receive careful consideration and should aim at catering, among other things, to mental, physical and social needs. The importance

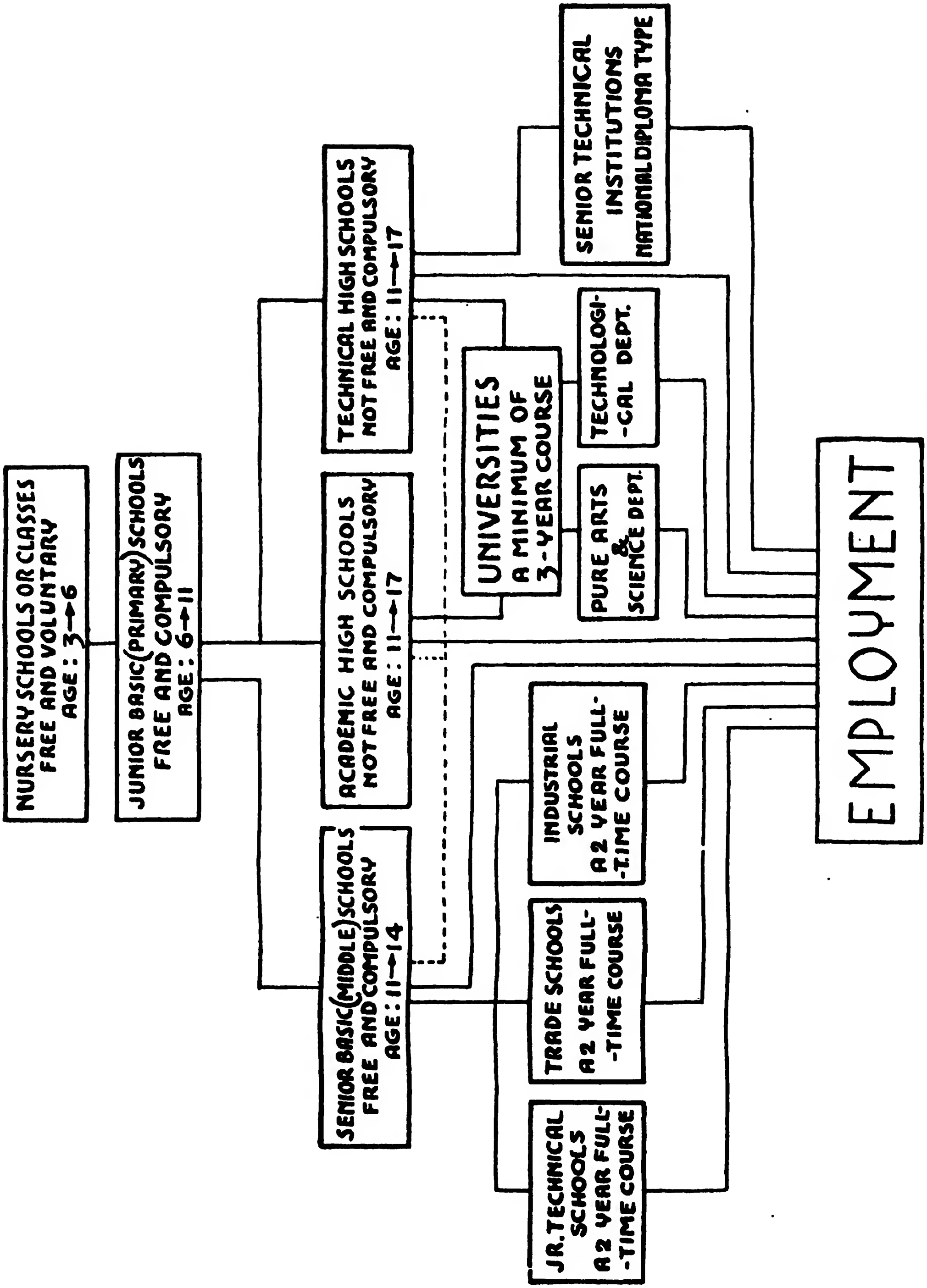

FIG. 1. Chart showing the Post-war Educational Scheme in India.

of nursery schools in urban and industrial areas where mothers go out on work has been specially emphasized. For these, sufficient number of nursery schools and nursery classes attached to the Junior Basic (Primary) Schools should be set up in urban and rural areas. The Board recommends that the nursery school age should be fixed at three to six. Attendance to nursery schools or classes should be voluntary, as in England, but the parents should be persuaded to send their children to receive this important stage of education. The organization of post-war education should secure that about 1 child in 7 attends nursery schools or classes, and on that basis arrangement should be made for 35,00,000 places. However, to start with the scheme it will be sufficient to provide for one-third the number, *i.e.*, about 10,00,000 places. Pre-Primary education should be in all cases free and women teachers should be employed as a rule. The net cost for pre-primary education in full operation has been estimated at Rs. 3,18,40,000.

Junior Basic (Primary) Schools.

A national system of education must recognize and make ample provisions for compulsory education which should be free and universal. The Board has laid all emphasis on this stage as a *prima facie* requirement in the proposed educational system. The case for introducing free, universal and compulsory education has been made out in the Board's report in the following fitting words: "In the first place, therefore, a national system can hardly be other than universal. Secondly, it must also be compulsory, if the grave wastage which exists today under a voluntary system is not to be perpetuated and even aggravated. And thirdly, if education is to be universal and compulsory, equity requires that it should be free and common sense demands that it should last long enough to secure its fundamental objective." Opinion is, however, divided on the question of the compulsory school age limits, but the age-range from six to fourteen *i.e.*, a period of eight years, has been recommended in persuance of the American and European pre-war practice of fixing the period for compulsory education at five or six to fourteen or fifteen.

The education received in this period has been termed "Basic Education" of which the Board has recognized two distinct stages, *viz.*, (*a*) the Junior Basic stage and (*b*) the Senior Basic* stage. The need for such differentiation of the Basic Education arises principally out of two reasons; (1) at about the age of eleven or twelve, boys and girls step into adolescence with certain mental and physical changes which require an adjustment both of the contents of the curriculum as well as of the methods of teaching; (2) a certain stage should be fixed at which capable boys and girls may be diverted to the high schools. Accordingly the age-range of pupils receiving Junior Basic (Primary) education has been decided to be from 6 to 11. The provision for this stage of education will be made in the Junior Basic Schools where boys and girls of all ages between 6 and 11 will be accommodated. On completion of the course prescribed for Junior Basic Schools the majority of the pupils, both boys and girls (80 per cent) will proceed to the Senior Basic (Middle) Schools, while the remaining 20 per cent of pupils who show greater capability and promise will be admitted to the High Schools. This has been clearly indicated in the chart. Under no circumstances will a boy's or a girl's education be allowed to terminate at the Junior Basic stage where a pupil is not expected to learn enough to ensure the minimum preparation for life, far less for citizenship. For late bloomers, *i.e.*, those who show promise later (*i.e.*, after 11), there is provision for transfer to High Schools at 13.

The number of pupils of age-groups between 6 to 11 at the Junior Basic Schools has been estimated at 3,60,00,000, according to the statistics provided by the Public Health Commissioner's Report (1940). This would require about 12,00,000 teachers, of which three-fifths should be preferably women, on the basis of one teacher per 30 pupils. Vernacular should be the medium of instruction. English as an optional subject in the Basic Schools should be eliminated, but replaced by a common language, such as Hindustani. The total gross expenditure per annum for Junior Basic Education, when in full operation, has been estimated at Rs. 114,29,00,000.

Senior Basic (Middle) Schools.

As already pointed out, 80 per cent or four-fifths of the pupils leaving Junior Basic Schools will proceed to the Senior Basic Schools to complete the remaining three years of their period of free and compulsory education. In view of the fact that the school education of the large population of the future citizens of India will come to an end on completion of the course provided in the Senior Basic Schools, the education in the Middle Schools should be carefully planned and devised so that it may be sufficiently complete in itself. The pupil leaving the Senior Basic School should be prepared to enter into professions and take his place in the community as a worker and as a future citizen. The demand for the great mass of semi-skilled and unskilled labour in agriculture as well as in industry will generally be met by these pupils. It is, moreover, suggested that

* Some have suggested 'Primary' for Junior Basic and 'Middle' for Senior Basic.

as the agricultural needs must always remain by far the most important factor in India's economy the Senior Basic Schools in rural areas should have an agricultural bias.

As already noted, among the pupils attending the Senior Basic Schools there may be cases of late development of proficiency, and as such their claim to be admitted to the High Schools from the Middle Schools has also been given due consideration (indicated by the broken line in the chart). A small percentage of the Middle School leavers seeking further training for better employment may proceed to Junior Technical, Trade or Industrial Schools whose function and scope will appear in what follows. The Senior Basic Schools will be required to look after about 156,00,000 pupils and the services of about 6,00,000 teachers, of which half should be women, will be necessary. The total annual cost has been estimated at Rs. 86,50,00,000.

Junior Technical, Trade and Industrial Schools

Organized industry requires a steady supply of trained and semi-skilled craftsmen. In the Senior Basic Schools the pupils will learn only the rudiments of craft work. To acquire the necessary skill further training is essential. Hence the necessity of such schools as the Junior Technical, Trade and Industrial Schools to which pupils aspiring for better vocation in life may proceed for further training in various crafts, after completing the Senior Basic education. Education in such schools will be voluntary and not free, though the State will be required to provide adequate grants. A provision for 2,00,000 places in these schools has been suggested.

High Schools

Adequate provision for higher and more thorough education for those who are much above the average level in capabilities has been recognized in every civilized country. The High Schools represent the first stage in an educational system where the process of selection of the cream of future citizens of a country begins. In planning for a nation's minimum educational needs, High School education cannot be made compulsory if only for financial reasons and has to be restricted to the few more capable who are expected to make the most of it. If the experience of other countries is to be depended upon, the choice should fall on one out of every four or five pupils leaving Junior Basic Schools, and accordingly the Board has recommended the divertion of 20 per cent of the Primary School leavers to High Schools. At first it will not be possible to make High School education free, though desirable ; but adequate financial measures should be provided to enable poor but capable pupils to derive the full benefit of High School education. The total number of places to be arranged for in the High Schools on the above selection basis has been calculated to be 72,52,920, boys and girls taken together, which would require about 3,62,640 teachers (one teacher per 20 pupils). The net annual cost of High School system, which the Government will be called upon to bear, has been calculated on the basis that only 50 per cent of the students will produce fees (Rs. 6/- per mensem) amounting to 30 per cent of the gross expenditure and that private grants will produce another 5 per cent. It will roughly amount to Rs. 50 crores. Total gross expenditure per annum will, however, amount to about Rs. 79 crores. It is to be noted that the admission of the pupils failing to attend the required standard of proficiency to the High Schools, though discouraged in the nation's interest, will not be made impossible if their parents are prepared to defray all of their educational expenses. Here we may do well to glance at the Table I,* showing the age-range, number of pupils and teachers, average salary of teacher, total gross cost etc., for the Primary, Middle and High Schools.

The period of High School education, according to the recommendation of the Board, will be 6 years from the age of 11 to 17. Here again, as in the Senior Basic Schools, the majority of pupils will finish their career as students on completing the six year course and will seek employment. So High School education should be more or less complete in itself and should not be looked upon merely as a preliminary to University education as it is now being done erroneously. At the same time the fact that the flow of the most able pupils to the Universities will take place from the High Schools should not be lost sight of. In view of the Board's recommendation in favour of the abolition of the Intermediate stage from the University education, the present first year course will be included into the High School course. The High School education will be divided into junior and senior departments to facilitate the transfer of students from the Senior Basic to the High Schools. The High Schools should be of two main types, (*a*) the Academic High Schools and (*b*) the Technical High Schools. The transfer of students from the Academic to Technical High Schools and vice versa will also be made possible. The scope and function of these two types of schools will now be briefly treated in two separate sections.

* Taken from Mr John Sargent's paper on 'The Practical Aspect of Educational Reconstruction', being his presidential address for the Section of Psychology and Educational Science at the 31st Session of the Indian Science Congress, 1944.

(a) The Academic High Schools

The main object of the Academic High Schools will be to impart education in the arts and pure sciences. The following subjects have been recommended to be included in the curriculum, *viz.*, the Mother Tongue, English, History (Indian and World), Geography (Indian and World), Mathematics, Science (Physics, Chemistry, Biology, Physiology and Hygiene), Economics, Agriculture, Civics, Art, Music, and Physical Training. On leaving the Academic High Schools, the student will generally enter into professions, and only a small fraction, say one in every fifteen pupils, will proceed to the Universities for higher studies. Students from the Academic High Schools will, however, be accommodated in the departments of Pure Arts and Science. All these are indicated in the chart.

industrial occupations. While all these are partly true, these do not tell us the whole truth. The system of English education, now in vogue, was introduced largely with a view to turning out an army of clerks needed in the Government offices and in the foreign commercial concerns doing business in the country, and to train up a handful of people to run the bureaucratic machinery of the Government. Industrialization of this country was never accepted as a policy of the British rule in India for obvious reasons, and as such the need for technical education was hardly felt. It is all too natural that official explanation has always exploited apathy of Indian people towards industry in its effort to hide the inherent weaknesses and defects of a foreign rule.

There are, however, reasons to believe that in the post-war period India will undergo certain ex-

TABLE 1

	Age range	*Estimated No. of pupils (lakhs)	†No. of teachers required	‡Average salary per teacher per mensem	§ Total salary bill per annum (lakhs)	‖ Other expenditure (lakhs)	Total gross cost per annum (Lakhs)	Cost per pupil per annum
	1	2	3	4	5	6	7	8
Primary Schools ..	6 11	3,60	12,00,000	Rs. 42-8	Rs. 80,00	Rs. 34,29	Rs. 114,29	Rs. 31·84
Middle Schools ..	11--14	1,56	6,00,000	Rs. 61-8	Rs. 60,55	Rs. 25,95	Rs. 86,50	Rs. 55·31
High Schools ..	11—17	72	3,60,000	½ at Rs. 61-8 ½ at Rs. 120-0	Rs. 18,69 Rs. 36,47	Rs. 23,64	Rs. 78,80	Rs. 109·44
		5·88	21,60,000		Rs. 195,71	Rs. 83,88	Rs. 279,59	

(b) The Technical High Schools

Technical Education represents the most important aspect of a national system of education in this age of industry and technology. Hitherto, there has been little or no development of this phase of education. This is not to be wondered at if the industrial backwardness of India be considered. In fact, the Board has attributed it to the limited number of openings available in industry, to the practice of filling the more remunerative posts with imported technicians and to the disinclination of the young Indians of the middle and upper classes to enter into

pansion of industry, though its extent is yet unpredictable, under pressure of events in India and abroad requiring an ever increasing number of trained personnel. The plan for a comprehensive system of technical education should be worked out and made ready while the guns are still thundering. The strong emphasis which the Board has laid on technical education in the scheme for post-war educational development has been, therefore, most welcome. The scheme is largely based on the report of Messrs Abbott and Wood, the two British experts on technical education, who visited this country in 1936-37, surveyed the position of India with regard to techni-

* The estimate is based on Public Health Commissioner's Report of 1940. Of the 11—14 age group four-fifths are shown in Middle Schools, one-fifth in the middle section of High Schools.

† One teacher to 30 pupils in Primary Schools, one to 25 in Middle Schools, one to 20 in High Schools.

‡ Average salary on the basic scales in accordance with Government's actuarial calculation.

§ Additions have been made for head teachers, higher scales in urban areas, house allowances, Government contribution to pensions or provident funds, etc. Teachers' salaries are taken as accounting for 70 per cent of the total gross cost.

‖ This includes expenditure on (*a*) loan charges, (*b*) special services, including school medical service, special schools, etc., (*c*) administration, (*d*) books, stationery, apparatus and equipment, (*e*) maintenance and repair of buildings and furniture and miscellaneous charges. Other expenditure is taken as accounting for 30 per cent. of the total gross cost.

cal education and submitted a very valuable report which was published some years ago. Speaking of the necessity of technical education Mr Abbott remarked:

> "No country can initiate and carry on industries on a large scale, unless it has an adequate supply of men specially trained for the direction and management of large industrial concerns as well as of others qualified for the minor but very important supervisory posts in them. On the other hand it cannot be expected that capable and ambitious men will devote themselves to acquiring this special knowledge and skill unless they see a reasonable prospect of exercising it and gaining a decent livelihood thereby."

Significant as the remark is, particular attention should be drawn to its latter part which is suggestive of the high status the technical education should enjoy in the community.

The primary function of technical education will be to meet the needs of industry and commerce for (1) skilled craftsmen, (2) intelligent executives, foremen, charge hands, etc. and (3) research workers. Technical education should on no account be regarded inferior to the academic type of education, and while students must be taught to be practical, their interest in academic subjects should also be maintained to a reasonable extent.

The Technical High Schools, to which reference has already been made, represent the most important stage of technical education in the proposed scheme. On completing the course in the Junior Basic Schools, capable pupils liking technical subjects or aspiring for technical occupations later in life may proceed to such schools where, as in Academic High School, a six-year course will be provided. The Board recommends that wherever circumstances permit, polytechnics should be preferred to monotechnics. The following subjects will be taught in the Technical High Schools: (1) the Mother Tongue (2) English, (3) Modern Languages, (4) History (Indian and World), (5) Geography (Indian and World), (6) Mathematics, (7) Physics, (8) Chemistry, (9) Biology, (10) Economics, (11) Technical subjects (wood and metal work, elementary engineering, measured drawing, etc.), (12) Commerce (book-keeping, shorthand, typewriting, accountancy, commercial practice, etc.), (13) Agriculture, (14) Art (including designs for industrial and commercial purposes), (15) Music and (16) Physical Training. The total number of places for which arrangement should be made in Technical High Schools has not been clearly indicated, though the total number of places in the High Schools, both types considered, has been estimated at about 72·53 lakhs. This will largely be determined by the demand and growth of Indian industries in future.

Many will complete their educational career at the Technical High Schools like those proceeding to Academic High Schools or Senior Basic Schools and will seek employment. Demand for skilled craftsmen in industry will be met generally by Technical High School pupils. The more ambitious and capable pupils may, however, proceed to Senior Technical Institutions or to the technological department of the Universities for higher studies.

Senior Technical Institutions

A full-time course of the National Diploma type will be provided in these institutions. The first diploma course will cover a period of 3 years. Successful pupils may prepare for another two-year full-time advanced diploma course. Students receiving such higher technical course will be eligible for the important posts of minor executives, foremen, charge-hands, etc. Creation of about 75,000 places in Senior Technical Institutions has been recommended.

Universities

The Board has made a scathing criticism of the university education obtained in this country at present. The alarming number of unemployed graduates, the large number of failures in the University examinations, unrestricted admission of students to the University classes etc. points unmistakably to the urgent need of a thorough reorganization of University education in India. The report reveals that only a limited number, say 30 per cent of the graduates, is absorbed in employment of a type commensurate with their attainments or with the time and money spent on such education. The percentage of failures at the B.A. and B.Sc. examinations of all the British Indian Universities in 1940-41 has been calculated to be 46 per cent. Such high percentage of failure is unique and characteristic of Indian Universities and is nowhere to be found outside India. This is largely the outcome of unrestricted admission without any consideration of the ability of the students for higher education. It has been found that, if Intermediate students are included in the University, one in three or, if they are not included, one in five of the High School leavers goes to University. In England, Germany and the United States one out of seven High School pupils seeks admission to Universities. The ill-conceived examination system is also no less responsible. The passing of the examination is more a matter of chance than of real education and scholarship. Speaking of the Universities, Mr. Sargent remarked that 'their examination system does not encourage original thinking and real scholarship and that their general organization does not secure that close personal contact between students and teachers from which greatest benefits of University life are usually derived.'

However, this high admission may create the wrong impression that Indian Universities are highly

developed and that their number is more than sufficient for this country. The illusion will, however, disappear if these statistics are judged against the background of the entire population of India. Thus before the war, the proportion of University students to the total population was 1 to 690 in Germany, 1 to 837 in Great Britain, 1 to 225 in the United States, 1 to 300 in Russia, and 1 to 2,206 in India. Again, while there are 12 Universities in England for a population of 41 millions and 13 in Canada for a population of 8½ millions, there are only 18 Universities in India for a population of 400 millions. Thus here in the University education also, India finds herself the most backward of all principal countries of the world. The high proportion of students in Indian Universities as compared to the school-going population indicates, as the Board has pointed out, that the super structure of the educational system was allowed to develop before the main edifice could be errected on broad and sound foundations.

In view of these drawbacks and difficulties, the Board has suggested that admission to Universities should be carefully controlled by introducing a proper selection basis, whereby only the students with reasonable promise may be given the scope of University education. For this purpose, it is proposed to introduce a standard of proficiency which at least one out of fifteen High School leavers may be expected to attain. On this basis, the Universities will be called upon to admit annually about 74,000 matriculates.

The next recommendation concerns the abolition of the present intermediate stage. Intermediate classes are now provided in many Indian Universities, but the students completing this stage are neither regarded as under-graduates, nor are they given any special consideration at the time of appointment. Further the course now followed does not also mark any definite stage of education. Some years back the C. A. B., the Inter-University Board and some other bodies suggested reorganization of the University education by abolishing the Intermediate stage. The Board now approves of this recommendation and accordingly suggests a three-year degree course as the minimum duration of a University course of study—a practice which is being successfully followed by European and American Universities.

Granting, therefore, that about one out of fifteen High School leavers should prosecute further studies in the Universities and that Universities should make provisions for a three-year degree course, post-graduate classes and adequate research work, it has been calculated that about 2,40,000 places will be needed in Universities throughout British India. At present there are about 1,21,484 students in all stages in the University course so that the proposed expansion of Indian universities should be sufficient to handle successfully double the existing number. The total annual cost, on the basis that Rs. 400/- will have to be spent on each student (excluding maintenance), has been estimated at Rs. 9,60,00,000. 30 per cent of this expenditure will be realized from tuition fees (only half the number will produce tuition gees) and private grants, leaving the Government to provide 70 per cent of the total expenditure, i.e., Rs. 6,72,00,000 annually, from public fund.

Financing the Scheme

Any discussion of the post-war educational scheme will be incomplete without any reference to

TABLE 2

	Estimated gross annual expenditure	Estimated income from sources other than public funds	Estimated net expenditure to be met from public funds
	Rs. in lakhs	Rs. in lakhs	Rs. in lakhs
1. Basic (Primary and Middle) Education	200,00	—	200,00
2. Pre-Primary Education	3,20	—	3,20
3. High School Education	79,00	29,00	50,00
4. University Education	9,60	2,90	6,70
5. Technical, Commercial and Art Education	10,00	2,00	8,00
6. Adult Education ..	3,00	—	3,00
7. Training of Teachers	6,20	1,70	4,50
8. School Medical Service*	—	—	—
9. Education of the Handicapped* ..	—	—	—
10. Recreative and Social Activities ..	1,00	—	1,00
11. Employment Bureaux† ..	60	—	60
12. Administration‡ ..	—	—	—
Total ..	312,60	35,60	277,00

* An amount equal to 10 per cent of the gross expenditure at the appropriate stages has been provided to meet the cost of the School Medical Service and Education of the Handicapped.

† Special provision has been made for this service in the beginning; ultimately it should be absorbed in Administration.

‡ Provision to cover the cost of Administration has been included at all stages. It is assumed that this will approximate to 5 per cent of the gross expenditure.

the financial issues involved in implementing the scheme. While dealing with the different stages of the educational structure, we have already quoted figures of annual expenditure for each stage. The adjoining table [Table 2] containing the estimated annual cost of the various branches of education, when in full working order, including those not discussed in this article, will be useful. These figures have, however, been worked out on pre-war standards and are liable to modification in the event of any future change in the standard of living or increase in population, whose extent is at present unpredictable.

Thus we find that the Government will be required to spend annually about Rs. 277 crores, when the scheme is in full working order. The extent of the educational development which the scheme seeks to introduce in the post-war period will now be apparent from the fact that the present total expenditure on education, so far as the figures for the year 1940-41 go, amounts to about Rs. 30 crores, of which about Rs. 17½ crores come from public funds. The scheme will be gradually introduced in the form of eight five year plans covering a period of 40 years and the peak gross expenditure of Rs. 312 crores will not be reached until the 40th year after its introduction. The incidence of the increased cost of education as the five year programmes are successively introduced has been roughly calculated and is indicated as follows:—

5th year	Rs. 10,00 lakhs.
10th year	Rs. 23,80 ,,
15th year	Rs. 37,40 ,,
20th year	Rs. 61,45 ,,
25th year	Rs. 106,00 ,,
30th year	Rs. 165,00 ,,
35th year	Rs. 250,00 ,,
40th year	Rs. 312,00 ,,

The main activities during the first five years will be in the direction of planning, propaganda, training of teachers, administration and organization of personnel. The required number of schools and colleges in different areas will also be established during this period. The remaining seven five-year programmes will be devoted to the actual carrying out of the scheme.

It is to be noted that a very large percentage of the estimated gross annual expenditure accounts for teachers' salary. Let us only consider the Primary, Middle and the High School education. Largest amounts of expenditure are involved in these three stages of education, whose combined gross annual expenditure has been estimated at about Rs. 279 crores out of the total expenditure of Rs. 312 crores. As indicated in Table I, Rs. 196 crores, *i.e.*, about 70 per cent. of this expenditure, will acount for the payment of the teachers' salary bill. This sum by no means represents a very liberal financial provision for the teachers who are at present hopelessly ill-paid, as the detailed statement of the teachers' grade in different stages of education (Table 3) clearly indicates. The Board has rightly realized that the success of the national system of education depends entirely on the availability of the right type of teachers. Unless the pay and the status of the teachers are reasonably improved, it is futile to expect right type of men with proper training and attainments to join the teaching profession which is now

TABLE 3

Schools	Classification of Teachers	Scale per mensem*
Junior Basic (Primary) Schools (including Infants & Nursery Schools)	Assistant Teachers ..	Rs. 3-1-35-3 (biennially) ?50 p.m.
	Head Teachers of schools having	
	(*a*) 1 or 2 class section	Rs. 10 above scale for assistants.
	(*b*) 3, 4 or 5 class section	Rs. 50-4-70.
	(*c*) 5 or 6 to 8 or 10 class section	Rs. 60-4-80
Senior Basic (Middle) Schools (Vernacular and Anglo-Vernacular)	Assistant Teachers ..	Rs. 40-2-80
	Head Teachers of schools having	
	(*a*) 3 or 4 class section	Rs. 80-4-100
	(*b*) 4 or 5 to 6 or 8 class section	Rs. 90-4-110
	(*c*) Over 6 or 8 class section	Rs. 100-4-130
High Schools	Non-graduate Teachers	Rs. 40-2-80
	Graduate Trained Teachers	Rs. 70-5-150
	Head Masters and Head Mistresses of schools up to 250 pupils on roll	Rs. 175-10-255
	Up to 500 pupils on roll	Rs. 250-10-350
	Of over 500 pupils on roll	Rs. 350-15-500

* (1) Same scale for men and women.

(2) Teachers of village schools should have free house. Where this is not possible 10 per cent. should be added to their salaries.

(3) This scale which has been framed for what may be described as normal rural areas may be increased up to 50 per cent. to meet the needs of areas where the cost of living or other factors nessitate a more generous scale.

scarcely regarded as a service of any real public importance. Even after setting forth the scales, as enumerated in the table, the Board has expressed doubts whether such a salary scheme is attractive enough to secure the services of men and women with real teaching abilities.

The Board has suggested that this increased cost of education has to be met out of current revenues. This means a pressure on revenue which can only be reduced by simultaneously adopting a plan of industrialization of this country. With the return of peace, a large fraction of the sum now spent on defense can and should be diverted to finance the scheme. Further, during the initial period, recourse should be had to loan. These suggestions for solving the financial difficulties have been summarized as follows:—

"In regard to the large financial issues raised by these proposals the Board realize that the cost of education like that of other essential services must ultimately be met out of current revenues and that this will not be possible unless the taxable capacity of the country is increased many times. For this they can only look to an all-out development of the national resources through a rational expansion of industry on the one hand and the improvement of agriculture on the other. They believe, however, that neither of these will be possible without a wider extension of educational facilities and the spread of enlightenment and expert knowledge which this will promote. Indeed they are convinced that the development of India's economic resources and the expansion of her social services are inseparably connected and must proceed side by side. To enable a start to be made some risk, perhaps even a great risk, must be taken and the Board recommend that for this purpose the early stages of development will have to be financed out of loan or out of such capital balances as may be available. In no other way can a vicious circle be broken. It is true that some diversion to the social services of sums now devoted to defence may be possible in the post-war period and there is reason to believe that a Government prepared to face difficulties might succeed in releasing for these services substantial sums now in the possession of religious bodies after fully safeguarding the legitimate claims of the bodies concerned."

This financial issue has, however, proved disquieting to many; but this is inevitable and unavoidable. For a national system of education planned on an All-India basis to meet the educational needs of four hundred million people, the estimated expenditure is far from liberal. Then again it has been a planning not for the attainment of the highest educational level, but for the securing of the very minimum educational needs as recognized in any civilized country of the world. If this sum appears colossal, it is because India has so far spent little or nothing on education. India's present expenditure for war effort is far more colossal. Her poverty and economic condition can hardly allow her to undertake such a vast expenditure for a cause whose issues distantly affect India, if at all. But there has been so far no difficulty in securing this money and it has flowed in any amount from the Government exchequer. India's poverty has not proved any bar to this flow. Fighting the evils of mass illiteracy in India is no less important, if not greater, than fighting the Axis enemy. The money required to execute the scheme for post-war educational development can be secured without difficulty if the Government has the will to do it. It is over the question of this will that grave doubts have been expressed. In a leading article in SCIENCE AND CULTURE, April 1944, it has been rightly recognized that "a national system of education can be built up[illegible] by a free National Government". India is neither free, nor is governed by a National Government. This is the main obstacle in the way of implementing the scheme which has ultimately every chance of being no more useful than a mere decoration for the archives of the Imperial Secretariat.

There is a Chinese saying:

> "If you are planning for one year, plant grain;
> If you are planning for ten years, plant trees;
> If you are planning for a hundred years, plant men."

Trees may mature more slowly and men more quickly in India than in China but the moral applies to both. (*Report by the Central Advisory Board of Education*)

PLANNING FOR THE DAMODAR VALLEY

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READERS of SCIENCE AND CULTURE are aware of the problems of the Damodar river basin from the various articles which have appeared from time to time[1], and also from articles appearing in the daily press. To evolve proper measures for a radical solution of a problem of this type requires intensive study, and investigation by a large scientific and engineering staff. In the case of the Damodar, a large amount of such material already exists, of which the most important one is comprised in the report of Mr E. L. Glass. From this, and other materials and from a close study of the measures adopted in other countries, particularly the U.S.A. within the last few decades[2,3] we have tried to evolve a tentative scheme for the solution of the Damodar problems which we present to our readers, and to the public. The plan requires elucidation on many points and we have indicated what further work will be needed to bring it to perfection. But in spite of these shortcomings we have no doubt in our mind that the general outline is correct and may form the basis of far-reaching constructive work.

Though it is only the people of Bihar and Bengal who are directly concerned in this problem, our studies should prove of interest to the whole of India. Human life in India, from times immemorial, have developed in the valleys of the great rivers which have served as natural highways, as arteries for supply of water essential for agriculture and other essential human purposes. But for ages past, rivers have been interfered with in an unscientific way by different parties, producing very injurious effects on agriculture, public health and river communications. But modern scientific developments have enabled the advanced countries of the West and America not only to retard such evil effects, but to develop the rivers to the fullest extent for the above purposes and further to develop hydro-electric power, wherever possible, and thus enhance the nation's industrial capacity.

Huge reclamation works of such type have been undertaken and completed particularly in Soviet Russia and America, and one of the best known example is the Tennessee Valley reclamation scheme.[3] The underlying idea is to take the whole river valley as one unit, and explore the fullest possibilities of the river system for purposes of agriculture, navigation and power-generation, and then take wholesale measures for reclamation.

In India, unfortunately, this unitary point of view has not been accepted, and the fullest possibilities of not a single river system has yet been completely explored. Piecemeal measures have been undertaken, with sometimes very disastrous results. Generally, but not always, irrigation has improved, but public health and communications have been impaired. No river has yet been fully explored from the standpoint of hydro-electric power development and use of this power for industrial purpose. It is time that we clearly comprehend the possibilities. In our studies we have tried to show that it is possible to treat the Damodar river basin, at no great cost, to full measures of planned reclamation, and thus convert a destructive river system into a beneficial agency, producing large amount of electrical power, ensuring water for irrigation and flushing of the lower basins throughout the year, removing the eternal menace to rail and road communication, and guaranteeing public health. *Nature, vested interests and thoughtless managements made a once prosperous valley a wilderness, but Nature, Man and Science can again make it a smiling garden.*

The source of trouble comes out of the maldistribution of water,—the rainfall coming in abrupt surges and lasting only for a short period in the year during the monsoon months. The solution of the problem lies in scientific storage and adequate management and distribution of the water resources of the basin, combined with land reclamation measures.

The mean annual precipitation in the Damodar catchment (upper and lower) is, according to Mr Glass, 24 million acre-ft.* in normal years of water which is 1/5 the corresponding amount in the Tennessee Valley. Of this amount 19 million acre ft. is precipitated in the upper reaches where the run-off is large. According to Mr Glass the run-off may vary in this region from 55 to 85 per cent. of the precipitation. In the lower valley which comprises the low flat alluvial soil of Bengal, the run-off may be as low as 15 to 20 per cent. If we take 50 per cent. as the mean run-off for the upper valley, it

* 23 Acre ft. = 1 million cu. ft.

would not probably be a high estimate. We may therefore suppose that about 9·5 million acre ft. of water reaches the two rivers Damodar and Barakar, in the approximate ratio of 3 : 2 (Selection p. 40). If this amount of water be averaged throughout the year, it will give us a flow of 14,000 cusecs at Raniganj due to the precipitation in the upper valley.

The flow is however very unevenly distributed. The average flow during the five rainy months (from middle of June to middle of November) is some 30,000 cusecs; for the remaining seven months, the average is about 1600 cusecs. The actual flow, it is well known, is extremely fluctuating and during the major part of the dry season, the river is almost dry. It is obvious that if a large percentage of the total run-off water is detained by dams the fluctuations can be smoothed off and a large even flow can be attained, as will be shown, for the greater part of the year.

We can also easily see that we have vast resources in power which now rolls down the river doing no useful work, but only occasional large scale mischief. The river descends from a height of 2000 ft. at the source to 285 ft. at Raniganj. Almost the whole of the descent can be utilised for the production of electrical power if a number of storage dams are erected at suitable sites on the main rivers and their tributaries.

Let us now calculate roughly the average amount of energy which the river dissipates in course of its descent from the hills to the sea. It is obviously an extremely difficult task. The river descends from a height of 2000 ft. to 285 ft. at Raniganj. We shall not be far wrong if we take the average *utilizable* descent to be 300 ft. for power generation, though it appears to the writers that the figure may be as large as 400 ft. A simple calculation shows that in the former case the total energy dissipated is nearly 3000 million kwh. (units), in the latter case 4000 million kwh. This is about 1/5 of the potential energy of the Tennessee River minus its affluents. In the calculation for the Damodar, all affluents excepting the Barakar have been left out, as there are practically no data about them. We shall presently see that about one-third of the river energy can be tapped, *i.e.*, about 1000 to 1200 million kwh. can be actually harnessed, and many suitable dam sites are available on the main rivers and their tributaries.

Whether for flood retardation, water control or power production, the core of the constructive work lies in the erection of a series of dams in the upper Damodar and Barakar regions, and a series of barrages in the lower reaches for distribution of water for irrigation and flushing. The plan for the multipurpose dams are indicated in the diagram (Fig. 1), which we now proceed to explain. The dams should be designed for flood-detention, irrigation, generation of hydro-electric power, and possibly also for navitation on, at least, a certain stretch of its length. There are references in the old records of the Calcutta Port-Commissioners, in the reports of the early coal miners, that the Damodar was navigable from its mouth up to the Raniganj area, and coal used to be transported to Calcutta in barges in the pre-railway days. Picture of ruins of the old wharves in the coal area are given in the Geological publications (see Fig. 2). But unfortunately no details are to be found anywhere as to the size of the barges, minimum draft and the season during which the river was navigable. At the present times the river stage is so low during the dry months that navigation is impossible, while during monsoons the stream is too furious to permit safe navigation.

The construction of dams on the Damodar river and its tributaries like the Barakar, Usri and others was suggested by Lt. Garnault as early as 1863 for the mitigation of the annual flood of the river. More detailed survey was undertaken by Mr Horn, Superintending Engineer, in 1901. After the devastating flood of 1913, first Mr B. L. Subarwal, then Mr Addams-Williams and later Mr E. L. Glass were deputed to recommend fuller remedial measures, after a scientific study of the problem. The results of these studies were presented in the form of four volumes of reports. Volume IV, and henceforward called the Glass Report, contains a summary and discussion of the recommendations, others contain tables and charts. We have drawn freely from these reports, and practically all our technical informations have been obtained from them.

Mr Glass, after survey, recommended the construction of flood detention dams on the main river and its tributaries. A large number of dam sites were surveyed, the details of which are summarised below. We shall consider the sites in two broad divisions, the Upper Damodar river and the tributaries, which lies above the confluence of the Barakar river. The other on the Barakar river and its tributaries. The map of the region is shown in fig. 4.

Dam Sites on the Damodar System

1. *Parjori Site.*—The most promising dam site on the Upper Damodar River is found near the village of Parjori which is 50 miles above the confluence of Damodar and Barakar, and 5 miles below the Jamunia mouth on the Damodar. This site commands a catchment area of 3,000 sq. miles which includes all the important tributaries except the Gowai river. The bed consists of thick layers of rock suitable for dam foundation, sluices and spillways.

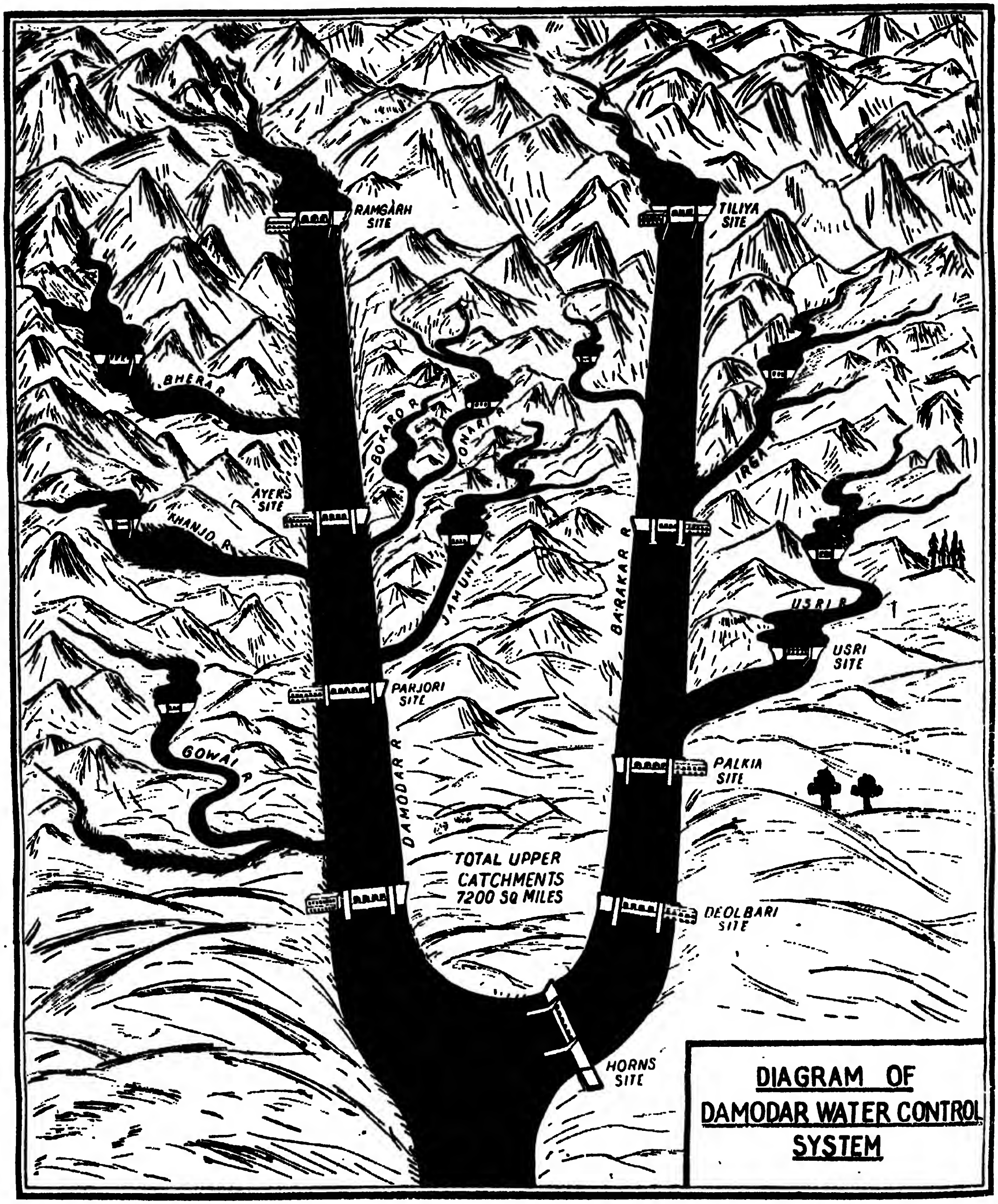

FIG. 1. Damodar Water Control System (Schematic) showing how the Dams should be constructed to conserve water resources for the purposes of adequate distribution and hydro-electric power generation.

The proposed 110 ft. high Parjori dam on the Damodar river will head up the reservoir water in the Jamunia also, but will not affect the railway bridge even at the full reservoir strength and although a small area on the western edge of the Jharia coalfield will be touched at high floods, no working pitheads will be submerged. The proposed reservoir will have a storage capacity of 15,000 m.c. ft. or 0·345 million acre ft.

It may be remembered that objection was raised by the Mining Association against the project of the construction of flood dam at Parjori (by Mr E. L. Glass in 1919) on the Upper Damodar river on the apprehension that there might be seepage of water along the faults or fractures in the rock bed at the reservoir site and might affect the working in the Jharia coal fields. Dr C. S. Fox (now Sir), of the Geological Survey, investigated the project in 1919 and was then of the same opinion as that of the Mining Association, but his opinion was not assertive to any great extent. But he has now completely changed his opinion.

"But since 1919, the Jharia coal field had been carefully re-surveyed (1926-29) and the geological structure of the coal field is now fairly accurately known and Dr Fox is of the opinion that there is little danger of such leakage into the mines. The only objection to the scheme was thus removed."

"It must be mentioned that the structure of the Jharia coal field was not fully known in 1919, and that as a result of his own (Dr Fox's) detailed geological survey of this coal field between 1926-29 he was able to say with confidence that due to the presence of dolerite dykes, which will act as underground groynes, and to the Dungri fault, which will draw off percolating water from the basin to the river above Amlabad, as well as to the destruction of the deeper coal seams by mica peridotites—percolation into the coal measures from a flood dam holding up 35 ft. of water (position of the sluices, in the proposed dam, above bed level) need not be taken too seriously. He then drew the attention of the Irrigation Department to this fact now so that they may revive the Parjori Retarding Basin project if they still felt any danger to the Burdwan district from high floods in the Damodar. Dr Fox considered such a potential danger still existed. If such a flood dam was now constructed the 35 ft. of water held up in the basin above the dam would ultimately silt up and, in the Jessop's bridge reach under construction, an additional 32 to 36 million tons of sand would be trapped. This additional sand would be nearly 20 ft. above the present river bed at the bridge, *i.e.*, almost half way up the piers. Dr Fox was unable, in the absence of more data, to say how soon such a basin would silt up, but he thought that 5 to 6 years could be taken as an approximate guess if no sand was removed for hydraulic stowing." (*Transaction of the Mining and Geological Institute of India*, 33, 1937).

It may be mentioned that the Mining Association was then thinking of 'stowing' up their pits, which entails the packing of the voids or caves, formed by the extraction of coal, by some other material, and sand is very suitable for this purpose. It may, however, be noted to the interest of the life of the proposed dam, that if sand is removed from time to time from the bed of the reservoir for the stowing purposes, the life of the dam will be greatly increased. The Jharia collieries raise at the rate of about 10 million tons of coal per year, which means that about 270 million cu. ft. of cavities are formed per year to be filled up by stowing. The quantity of sand requirtd is about 20 million tons.

The 3,000 sq. miles of the catchment area have an average monsoon precipitation of 43 inches. If we assume that the run-off is 50 per cent. the total volume of water reaching the Parjori reservoir is about 3·4 million acre ft. Taking the average 'head' as 60 ft. for power generation, the total energy poured down across the site is found equivalent to about 200 million units (kwh.) of electrical energy. Under actual operating condition, however, the available energy would be much less, depending upon the overall efficiency of the plant, which includes utilization factor for the total resources of water, turbine efficiency, power factor and other details. If the efficiency factor is taken to be 75 per cent. the total energy production will be 150 million units, but probably the height of the dam can be further increased.

Much of this power will be 'secondary' i.e., available only during the rainy seasons, unless the total storage capacity of the reservoirs is large enough. If a number of reservoirs is built up in the upper valley and on the tributaries, a large fraction of it can be converted into 'primary' power *i.e.*, it will be available throughout the year. On account of the proximity of the coal fields it will be possible to have auxiliary thermal generators for the dry seasons at no great cost.

The Parjori sites, we find, is very much similar to the Sherman Island power stations on the Hudson River, New York, in 1924. There the head was 60 ft. drainage basin 2,782 sq. miles, discharge rate 6,280 cusecs, and electrical energy obtained was 81 million units in a year. This quantity must have been increased within the last twenty years.

If the run-off water of the entire basin is released uniformly for six months it will give an average flow of 10,000 cusecs. With this flow and a head of 60 ft. it gives a power output of 50,000 kw. or 67,000 h.p.

2. *Ayar Site.*—About 17 miles above the Parjori site, there exists another dam site opposite the village of Ayar where a rocky rapid of 3 to 4 ft. height occurs. At the head of this rapid there is hard gneiss rock exposed right across the bed, a small hill on the right bank and the left bank slopes up at about one-in-fifty over 100 ft. above the bed. A dam, 100 ft. high would be about 4,000 ft. long (less than a mile) at crest level. The valley is deep and narrow. The storage capacity of the reservoir is

FIG. 2. Old coal-exporting ghat, near Egara, Raniganj coal-field. This view illustrates that coal used to be exported to Calcutta down the Damodar river during the monsoon period, previous to E. I. Railway constructed at Raniganj in 1815. (Reproduced from *Memoirs Geol. Surv. Ind.*, Vol. 61).

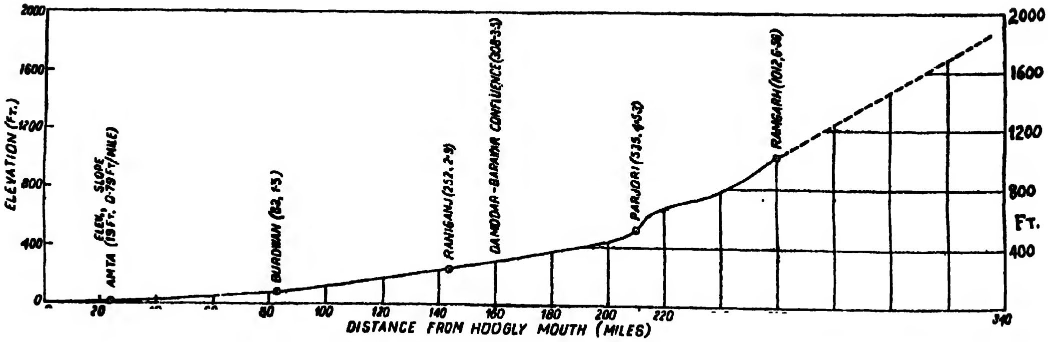

FIG. 3. Profile of the Damodar River (based on Lieut. Garnault's slope data, 1864).

therefore quite small. The catchment above the dam site is 2,000 sq. miles.

It appears therefore that this site would be suitable for a power dam provided a larger storage and regulating reservoir can be built above it. It may be noted with interest that there is a site near Ramgarh about 15 miles above Ayar. It is also possible, as Mr Glass noted, to control the head waters at the Bhera Nadi by a dam which would feed the main river above Ayar site.

Assuming 50 per cent. run-off of the 43 inches of rainfall, and 60 ft. available head, the energy which will be handled by the proposed Ayar dam calculates out to be some 133 million units in a year.

3. *Ramgarh Site.*—According to Mr Glass, Ramgarh is the uppermost site available for the construction of a dam. The site has a catchment area of about 1,000 sq. miles, and the proposed reservoir will have a storage capacity of 9,000 million cu. ft.

The water resources of this valley is about 1·1 million acre ft. in the monsoons, and assuming a head of 50 ft., the total energy dissipated by the river during this period is some 55 million units.

4. *Control of the Tributary Rivers.*—The possibilities of the head waters control in the tributaries of the Damodar river has not been properly investigated but their possibilities were not overlooked by Mr Glass.[5] The following affluents are of importance for flood detention and power projects:

Tributary River		*Catchment area*
Jamunia River		350 sq. miles
Konari River		730 sq. miles
Gowai River		450 sq. miles
	Total	1530 sq. miles

Thus these three tributaries control more than half of the Parjori catchment. But Mr Glass was not much interested in these sites as he observed that none of these would have large storage capacity for flood detention. He writes:

"I have considered the alternative of two or more dams on branches such as the Gowai. Jamunia and Konaree with a total catchment of say 1,000 sq. miles, but from what I have seen of the valleys of these affluents and know of the steep slopes of their beds, I am not at all hopeful of obtaining sufficient capacity at reasonable cost and much prefer to have a larger catchment under control."

These tributaries, as noted above, individually command catchment areas which are much larger than the Usri and Tiliya catchments. It will be discussed later that the Usri dam has been proposed as a power site.—The steep slope and deep valley which were mentioned by Mr Glass for the Gowai, Jamunia and Konaree rivers, might prove on further survey to be excellent dam sites with large available head for hydro-electric power generation. Mr Glass, however, was not so much interested in power projects as in flood control for which his service was specially requisitioned by the Government of Bengal. His valuable reports, however, gives us sufficient indication and guide for future survey on the modern ideas of dam construction for power generation as well as headwaters control for flood.

5. *Site between Parjori and Barakar junction.*—The river level at Parjori is 540 ft. and that at the junction is 285 ft., the distance between them being 50 miles. If dam sites can be found in this region, the tail waters from the Parjori can be used over again to generate electrical power. This would give us almost the same or a larger amount e.g., 200 million units, as obtainable at Parjori.

No attempt was however, made to discover any dam site in this stretch because

(1) the Parjori site alone was thought to be sufficient for flood dentention, and

(2) the depth of sand layer over the bed rock was considered to be too great for the construction of earthen or masonry dams.

According to Mr Gee,[12] the sand layer at this region is nearly 50 feet, and the average depth of the Damodar bed of sand may be taken to be 40 ft., although at places the thickness may be as great as 80 ft.

A few points should, however, be noted in this connection. It would be very lucky to get bare rock for dam foundation, but the engineers seldom have such luck. Where the overlying sand is deep, the construction of dam on such sites becomes more expensive. In the U.S.A. dam sites which were otherwise good have not been rejected even when the overlying layer of sand was as much as 100 ft. deep. For instance, the river bed at the Chickamauga dam on the Tennessee River is overlayed with 40 to 50 feet of sand clay and gravel,[14] and the Arrow rock Dam on the Boise River, Idaho State, U.S.A., has its foundation 91 ft. below the sand layer.[15] (p. 1066.)

TABLE 1

TOTAL ENERGY RESOURCES AT THE UPPER DAMODAR VALLEY OUT OF THE MONSOON WATERS

Parjori site	200 million units (kwh.)
Ayar	133
Ramgarh	55
Tributary sites (Total approx.)	100
Site between Parjori and Barakar junction ...	200
	688 million units.

The Barakar Basin

The Barakar River is the largest tributary of the Damodar, and contributes about 40 per cent. of the total flow in the Lower Damodar River. The control of the Barakar river is therefore equally important for flood control or other projects.

1. *Horn's Site*.—After the disastrous flood of 1900, Mr D. B. Horn, Superintending Engineer, was put on special duty to find out remedial measures to mitigate Damodar floods. Mr Horn selected a dam site on the Barakar river in 1902 at a place just above its confluence with the Damodar River, near the village of Durgapur. The location has been named Horn's site.

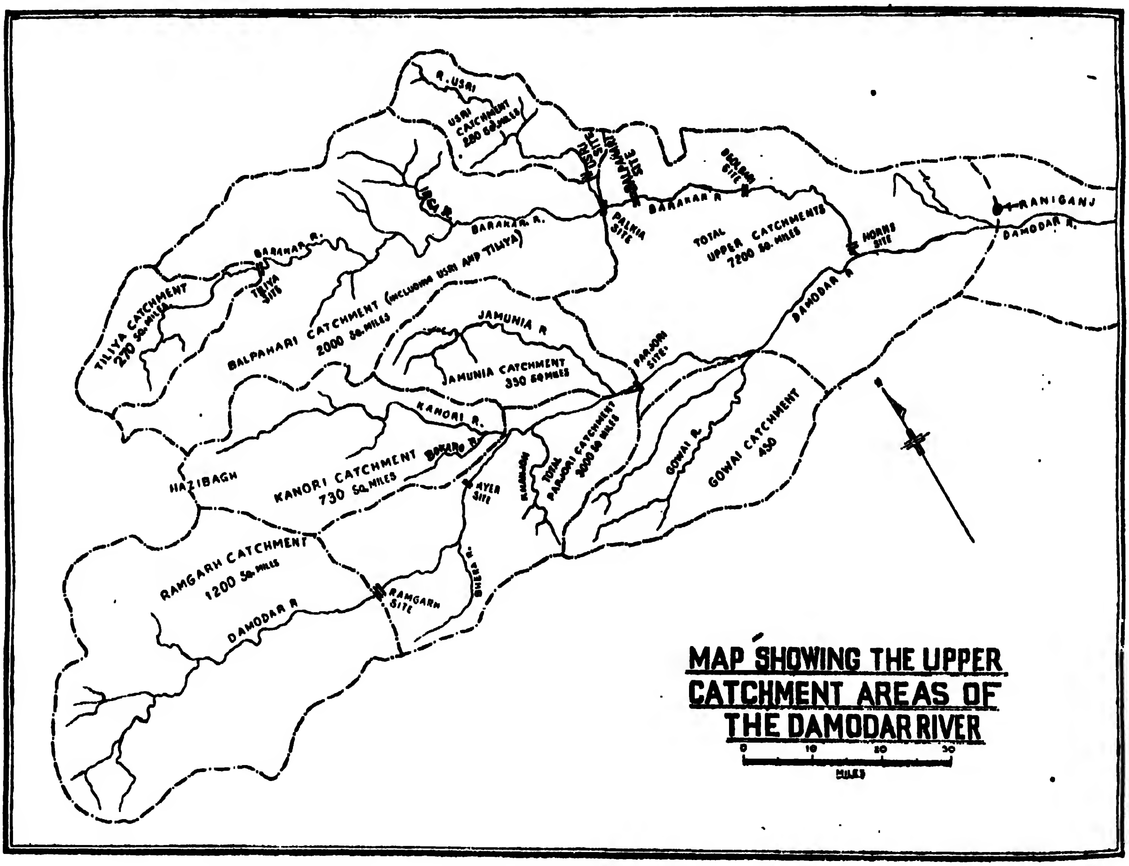

FIG. 4.

which will be impounded in this reservoir is about 8,640 million cu. ft. or 0·2 million acre ft. (1 million cu. ft. = 23 acre ft.).

Boring on the site showed that the bed rock is to be found 40—50 ft. below the overlying layer of sand. The site was discarded by Mr Addams-Williams because he thought that the depth of sand was too great. But as mentioned before, in America, dams are constructed even when the bed rock has been found a hundred feet below the surface.

This site will command practically the whole of the Barakar catchment. The amount of water running through the Barakar river in the year is some 3·8 million acre ft. which will pass down the Horn's site. Taking the available head to be 35 ft. the power resources at the dam site is about 133 million units.

The dam site is quite suitable and Mr Horn found that it is situated among the hills, where building material is plentiful. The gorge is fairly narrow and the slope of the bed is not more than 6 ft. per mile. A masonry dam of 70 ft. height will back up its water up to about 12 miles. The volume of water

2. *Deolbari Site*.—22 miles above Horn's site there is another dam site near the village of Deolbari.

The right bank of the Barakar river at this place rises steeply out of the river bed, and the left bank attains a height of over 90 ft., at a distance of 3,200 ft. from the river. The slope of the river bed is about 7 ft. per mile. A dam of 130 ft. in height can be constructed, impounding 17,000 million cu. ft. of water.

The bed rocks lies about 30 ft. below the sand, but the rocks themselves are not very much suitable for dam foundation, abutment and spillway.

Although the Deolbari site was rejected in 1918 due to some defects of the bed foundations, the similar experience of the Tennessee Valley Authority within the last ten years gives us ample scope for accepting such sites. To mention, the Norris Dam on the Tennesse Valley was found to have very inferior bed formation but this has been completely cured by cement grouting at the foundation rocks. Extensive grouting has also been adopted for the Guntersville and Chickamauga Dams.[14] It is therefore not unlikely that the Deolbari site may, after proper treatment of the foundation rocks, be found suitable for construction of masonry dam.

Taking 3·2 million acre ft. of water passing down the site at an average head of 50 ft., the total electrical energy comes out to be 160 million units.

3. *Palkia and Balpahari Sites.*—The best dam site on the Barakar river is near the village of Palkia about 16 miles above Deolbari or some 40 miles above the junction of the Barakar with Damodar. The proposed Palkia dam 125 ft. high will head up water in the Usri river also which has joined the Barakar river just at this site. The Palkia site commands a catchment area of 2,000 sq. miles with a monsoon resources of about 2·3 million acre ft. of flow water. The storage capacity of the reservoir would be about 20,000 m.c. ft. (or 0·46 million acre ft.) of water. Taking the available head to be 60 ft., the energy handled by the river is 138 million units during the monsoon. There is a site at Balpahari about 3 miles down the river, which is in certain respects better than Palkia, and the choice has to be made between these two sites.

4. *Tiliya Site.*—This is the uppermost dam site on the Barakar river, some 50 miles above the Usri junction, controlling 270 sq. miles of catchment area. Near the village of Tiliya, two ranges of low hills which hem in the river for about 7¾ miles approach within 1,600 ft. of one another. The slope of the bed being only 4·13 ft. per mile and the height of the hills more than 130 ft., a dam of at least 130 ft. could be adopted which would set back the water about 31½ miles. But the proximity of the Upper Barakar Bridge limits the size to 54 ft. This will pound up water about 13 miles.[8]

It may however be noted in this connection that in the TVA operations in the U.S.A., hundreds of miles of roads and railways had to be rearranged, old bridges removed, and new ones built,[15] (p. 917) so that if a site is otherwise good, railway alignments and bridges may not be regarded as 'Sacrosanct'.

The water resources of this site is about 0·25 million acre ft. Although the Tiliya site has a catchment area the same as that of the Usri river, the dam will give us more hydro-electric power than from the proposed Usri power project due to the higher head of water. The proposed Tiliya dam is 130 ft. high as compared to 70 ft. for the Usri project. With a head of 60 ft. the power resources at the Tiliya is nearly 15 million kwh.

5. *Usri Site.*—The Usri river is an important tributary to the Barakar river. The catchment area is 280 sq. miles and the run-off water of the basin is about 10,000 million cu. ft. (or 0·23 million acre ft.) during the entire monsoon. The proposed dam is 70 ft. in height so that the energy resources is shown to be about 7 million units.

The Usri river has a steep gradient so that a number of dams may be planned to utilize the maximum advantage of the drop of the river across successive dams, just as in the case of the dams on the Occoee, a tributary of the Tennessee.

TABLE 2

TOTAL ENERGY RESOURCES OF THE BARAKAR BASIN

Horn's Site	133 million kwh.
Deolbari	160
Balpahari	138
Tiliya	15
Usri	7
	453 million kwh.

With the help of these dams on the Damodar and Barakar we have the possibility of harnessing the total energy of 1,141 million units every year. Taking that about 75 per cent. of the resources is utilizable we can get some 850 million units. The gross sale proceeds of this amount is more than 2½ crores of rupees at the average rate of ½ anna per unit, and 1¼ crore at the rate of one quarter anna per unit.

To consider, on the other hand, the question of the water management and control, if all the above mentioned dams are constructed, about 30 per cent. of the total run-off can be stored up.

TABLE 3

STORAGE CAPACITIES AND CATCHMENT AREAS

	Dam Site	Storage capacity (million acre ft.)	Catchment area (sq. miles)	Storage capacity per sq. mile of catchment acre ft. SC. miles.
Damodar system.	Parjori	0·35	3,000	117
	Ayar	0·10	2,000	50
	Ramgarh	0·20	1,000	200
	3 Tributaries ..	0·30*	1,530	190
	Site below Parjori	0·40*	3,500	116
Barakar system.	Horn's site ..	0·20	2,500	80
	Deolbari	0·39	2,250	173
	Palkia	0·46	2,000	230
	Tiliya	0·15*	280	535
	Usri	0·12	270	440

* These figures are tentative.

It is difficult to give our readers any accurate figure for the cost of construction of the dams in absence of any detailed plan. But so far roughly estimated by Messrs Glass and Addams-Williams, in 1922, the three dams *viz.*, Parjori, Palkia and Usri would cost about two crores of rupees. But according to more recent ideas it seems that the cost would go up to 8-9 crores of rupees for the total storage of 1·5 million acre-ft. of water, which means about 60 rupees per acre-ft. To compare this figure with those of other countries we find that the Mississippi dams, designed only for flood detention, were planned with an average of about 40 rupees per acre-ft.[2], and for the Tennessee dams of the multipurpose type (flood detention, irrigation, navigation and hydro-electric power generation), the average goes above 100 rupees per acre ft. of storage[3]. Thus the rough costing for the Damodar dams is well within reasonable limits, and they are by all means economically practicable. The dams on our plan have a storage capacity of 2⅔ million acre-ft. (Table 3) and may cost between 25-30 crores of rupees at the average rate within 100 rupees per acre-ft. A direct income of about 2 crores of rupees would be turned out of hydro-electricity alone. The indirect income, due to all-round improvement of the upper and lower basins cannot be estimated.

We have not included, within this article, any plans for dealing with the lower basin below Raniganj. This region suffers from lack of water during the winter season, and hence no winter crop can be grown in about a million acres of excellent soil. Further, the part to the north and east of the river, on the left bank, suffers from malaria due to water starvation caused by embankments, and the region on the right bank from chronic water logging. It is obvious that the construction of reservoirs according to our plan will conserve about 30% af the total run off, *i.e.*, about 2·50 million acre ft., which can give us an average flow of about 5,000 cusecs during seven months of the dry season, and this will be great help for the reclamation of the lower basin. Detailed plans will be published later.

TREATMENT OF THE UPPER CATCHMENT AREAS

The Chota-Nagpur plateau from which the Damodar river and its tributaries emerge are mostly bare and denuded. About 3,500 sq. miles of the upper Damodar reaches are waste land or covered with meagre forests, while, about another 2,000 sq. miles are under cultivation. In the north Barakar basin, as reported by Mr Sabharwal[7], Bihar Conservator of Forests, there are extensive areas where all forests have entirely disappeared by repeated cutting, firing and uncontrolled grazing.

The bare areas are readily washed off and the rivers have to carry a heavy load of sand and silt. This deteriorates the channels of flow, and form sand bars and deltas near the mouth. The original soil gets more and more barren and has less power to soak and retain the rain waters.

It is highly desirable that the Government should take up the problem immediately and enforce laws for forest preservation and erosion control as suggested by Mr Sabharwal. The erosion control management will lie in regulation of cutting of forests, of grazing and pasture land, afforestation and planting, terracing, dyking, gully plugging, etc.[7]

AFFORESTATION AND WATER CONTROL

Afforestation in the upper catchment areas of the Damodar and Barakar rivers are strongly recommended for preventing erosion of soil, to improve the channel and lengthen the life of dams. Claims from certain quarters have been made that afforestation on the Damodar catchment areas would also be sufficient for prevention of floods, and no detention dams would be necessary, or if the dams are to be made they are only of secondary importance. We widely differ from this view and hold that *afforestation can, under no circumstances whatsoever, prevent catastrophic floods of the type that frequently ravage the Damodar Valley*. As their arguments are confusing and misleading it is necessary to examine them in a true scientific spirit. The claims of the afforestation enthusiasts are as fellows:

(1) *Effect on Rainfall.*—They claim that afforestation somehow, affects the rainfall in a basin.

There is, however, not a single iota of positive proof in support of this claim, although some have fancied that humidity of the sky in the area is to some extent increased by the presence of forests. Such effects, even if they exist, must be extremely small compared to the huge monsoon currents which are responsible for the precipitation on the Damodar Valley and the plains of India. These currents are due to atmospheric conditions in the Bay of Bengal, and these conditions cannot be modified by land conditions, and there is apparently no physical reason why these currents, which generally are thousands of fee in depth would be affected materially by the growth of forest in any area. *There has not yet been evolved any method by means of which man can control rainfall.*

(2) *Reduction of Flood Crests.*—It is generally found that vegetal cover of a tract reduces run-off of water by increasing the absorptive power of the soil for water. But the magnitude of the retardation of stream-flow is neither guaranteed nor has any generalised value. The problem has remained for long extremely controversial,—opinions going to extremes, on one hand some are of the opinion that the vegetal cover greatly reduces the stream flow, while others contend that afforestation increases flood tendencies.[11] On the Tennessee Valley, for example, the flood has generally decreased due to the deforestation of the catchment areas as analysed by S. M. Woodward, Chief Planner of the Tennessee Valley, at the Upstream Engineering Conference.[10]

Mr E. L. Glass considered this phase of hydrology in preparing his flood control project for the Damodar river, and remarked—

> "Large expenditure on afforestation seems inadvisable as heavy floods are caused entirely by prolonged heavy rainfall, when the soil is saturated and the absorption in forest humus is no more than in open country, though forests do no doubt reduce the smaller floods and the scouring of soil."[8] (p. 157).

This statement of Mr Glass requires some elucidation. The great flood of 1913 was due to precipitation of 12 inches of rainfall in course of 5 days in the catchment area above Raniganj. When such continuous heavy precipitation takes place, the ground is completely soaked, and can absorb no more water. In fact, the run-off was found by Glass to increase from 30 per cent. at the beginning to 85 per cent. at the end of this period of 5 days. The resistance offered by trees, dykes, or terracing would be quite useless, and they generally break down in the face of such heavy rush of water, and such measures can never prevent a catastrophic flood. In fact, the crest of the flood reached in 1913 was 6½ lacs of cusecs, and Mr Glass has shown by his illuminating analysis that every catastrophic flood occurring before this date was due to similar heavy and continuous precipitation extending over 72 hours or more in the catchment area.

So even admitting that afforestation can prevent the crest of floods due to normal, or slightly abnormal precipitation, it is obvious that such measure are quite ineffective against conditions which give rise to catastrophic floods. But it is these catastrophic floods which generally burst the embankments, and destroy communication lines, cities and villages, and preventive measures have to be devised against them. Against normal floods no prevention measrues need be taken.

Certain isolated laboratory and controlled field experiments, are however cited to show that the vegetal cover of a tract may lead to an absorption of the rainfall up to even 99 per cent. But can large natural river basins comprising millions of acres and containing thousands of hills and mounds be treated in the same way as controlled field experiments? In order, therefore, to get a constructive idea of any real significance of afforestation and other land treatment measures, it would be safer to learn from the statistical informations of the natural field conditions on different treatment. Mr H. H. Bennett, Chief of the U. S. Civilian Conservation Corps says,

> "Our work in the last two years in 141 watersheds throughout the country (U. S. A.) indicates that the volume of run-off water can be reduced 20 to 25 per cent through the use of erosion control methods."[13]

This figure therefore may be taken as the average maximum for the retardation of the run-off water, when complete afforestation, and erosion control measures, as far as practicable, are undertaken.

(3) *Ground Water.*—Any water soaked into the soil, will either be evaporated, utilized by plants, or find out its way by seepage as underground water. Does a vegetal cover increase or decrease the ground water? Evidence on this point is conflicting, though some are of opinion that a vegetal cover increases ground water. We see, however, that a part of the ground water is sucked up by the plants and ultimately evaporated off through the leaves. So there is a considerable transpiration loss of water due to forestation.

The seepage feed of the channels, it may be noted, does not necessarily increase with vegetal cover of the tract, for, we read:

> "The best ground water supply is found in regions of ample precipitation where both soil and subsoil are of fine sandy character and forest cover is absent"[10] (p. 211).

Professor Barrows[11] has cautioned very emphatically against the indiscriminate statements of the afforestation enthusiasts in the following words:

"Unfortunately, too, advocates of forestry in their zeal for forest preservation often make broad and unqualified statements characterising all forests as water conservators and using this often erroneous statement as their chief argument to justify continued forestation, instead of allowing the worthy objective to stand, as it should, on its own merits"[1] (p. 84).

We can thus sum up:—

(1) The chief utility of afforestation and other land treatment measures is in soil conservation, lengthening of the life of dams, retardation of normal flood crests to about a maximum of 20 per cent.

(2) The claim that afforestation and other allied treatments affect rainfall is absurd; the claim that they increase ground water is debatable.

(3) Catastrophic floods are due to a combination of physical conditions against which afforestation and land treatment measures are useless.

Problems of Silting of the Proposed Reservoirs

Under the conditions prevailing in 1918 the Damodar waters carry, according to Mr Glass, a silt load of 1/100 by volume during heavy surges of flood, but during average floods the proportion is 1/200, and for the entire monsoon, the average silt ratio is 1/500.

Let us now try to visualise how the deposition of the sand ensues in the reservoir. The load of sand and silt moves on in the stream when it runs with failry large velocity. When the stream enters the reservoir its speed is retarded to a great extent so that the suspended particles begins to settle freely to the bottom of the reservoir. The supernatent water passes down the spillway of the dam, free of sand, but may be charged only with the finest silt which still remains in suspension and passes on.

It is evident that if the catchment area above the dam is large it will supply erodable debris of soil in the stream proportional to its area. Thus, larger the catchment area, the larger the silt deposition for which the reservoir capacity should be increased in order to allow for the sedimentation without imparing the useful storage.

It is however difficult to asign a definite storage capacity of the reservoirs per sq. mile of the catchment area above it, unless the erodability of the basin is fully known. According to Mr Brown[16] it is important that a suitable minimum ratio of reservoir capacity to watershed area be provided. "This minimum ratio varies from 75 acre ft. per sq. mile in the Southern States to 250 acre ft. per sq. mile in the Texas-Oklahama region (desert), it depends on the rate of erosion, which is determined in part by vegetal cover on the watershed."[17] The Damodar-Barakar basin is obviously not as bad as Texas-Oklahama which is abnormally erodable. Table 3 shows the storage capacity, catchment area and their ratio for the proposed reservoirs on the Damodar river and its tributaries.

The problems of silting of the Damodar reservoirs were considered by Mr Glass (1919) and by Mr Kanwar Sain[8] (1944), the results of which is extremely hopeful and satisfactory. It would be illuminating to quote the relevant portions of the discussions to elucidate the points.

"Considering the average monsoon rainfall as 43 inches and assuming 40 per cent run-off, the total volume of monsoon flow per year per 100 sq. miles of catchment area would be $100 \times 2{,}323{,}200 \times 43 \times 0{\cdot}4 = 3{,}995{,}904{,}000$ cu. ft. or nearly 4,000 million cu. ft.

"Taking the average silt ratio as 1/500 the total volume of silt carried during 50 years from a catchment area of 3,000 sq. miles (Parjori catchment) would be 12,000 million cu. ft. or nearly 60 per cent of the reservoir capacity (Parjori Reservoir 15,000 m. cu. ft.).

"Mr Glass has added that some of this silt would pass out directly through the conduits, while the remainder would drop in the basins, some to remain and some to pass out through the conduits later on with ordinary monsoon flow. It is evident from the above consileration that it would be an extremely long time before the basins silted up sufficiently to impair their usefulness and the safety of the dams.

"This was for Palkia and Parjori basins. For Usri, assuming the same average silt ratio of 1/500, Mr Glass worked out the annual volume of silt deposited in the reservoir as about 20 million cu. ft. or 0·8 per cent of the total capacity. Mr Glass concluded 'This need not cause apprehension as it would take over 30 years to reduce the capacity by 25 per cent and this period would be extended by the passage of some fine silt through the sluices and over the spillway, while some of the deposit would be above spillway crest level in the upper basin provided for flood detention'."

The observation in the silt-ratio of the Damodar river as given by Mr Glass is not very accurate. Mr Kanwar Sain points out "Mr Glass' estimate given above is based on one season's observations only. The actual solid matter according to observations come to 1/828 by volume. Mr Glass increased it to 1/663 by applying specific gravity of clay and silt. This correction is open to question. Captain Garnault found the proportion to be 1/590. These observations were for small floods. In heavier floods the silt concentration may be heavier. According to Faris the maximum silt percentage usually occurs prior to the maximum stream discharge."

We collect the following comparative silt loads in different streams, from Mr Kanwar Sain's note[8]:

TABLE 4

COMPARATIVE SILT LOADS

River.	Silt ratio by volume Ratio	Percentage	Remarks.
Damodar	1/500	0·20	Mr Glass' one season's obsn.
"	1/828	0·12	Average of obsns.
"	1/663	0·15	Correction with Sp. Gr. of clay by Mr Glass.
"	1/590	0·17	Capt. Garnault.
Bhakra (Punjab)		0·084 to 0·186	All seasons between 1916-33.
"		0·15 to 0·45	During monsoon.
Rio Grande (U.S.A.)		0·25 to 0·5*	Spring floods.
"		2·0 to 5*	Flashy summer floods.

* Figures are originally given as 0·5 to 1 per cent and 4 to 10 per cent by weight. We have taken sp. gr. of soil roughly 2 to get these figures.

"After examining a large number of cases varying from 181 to 167,000 sq. miles of catchment areas and scattered over America, South Africa, Burma and the Punjab which catchments giving rise to heavy silt charged streams, Khosla arrived at the following conclusions:

"(a) The rate of silting falls off with years.

"(b) The annual rate of silting per 100 sq. miles of catchment has an upper average limit of 75 acre ft. for arid catchments which give rise to heavily silt laden streams. The absolute maximum rate for any major catchment will, perhaps, not exceed 90 acre ft."

That the life of the proposed dams on the Damodar and Barakar rivers will be about 200 years even under the existing silt-load conditions of the streams has been shown by Mr Kanwar Sain by more detailed calculations:

"The probable silting of the Damodar reservoirs may be roughly estimated by comparing the silting rates of other reservoirs exposed to similar conditions as prevailed on the Damodar.

"The Soil Conservation Service (U.S.A.) has made considerable studies of sediment surveys in existing reservoirs. From this data Berard J. Witzig* has evolved the following formula:

$$\Delta S_R = I(S_R)^x$$

in which ΔS_R = annual silting rate of depletion or depletion of storage – in acre ft. per 100 sq. miles of drainage area; I = Coefficient, called the 'regeonal index'; S_R = original storage, in acre ft. per sq. mile of drainage area; $x = 0{\cdot}83$ = graphic slope of the plot on logarithmic paper.

"The regional indices for Elephant Butte Dam on Rio Grande River, New Mexico, and Roosevelt Dam on the Salt River, Arizona, in Witzig's formula work out to be 1·51 and 0·69 respectively. Applying the mean (= 1·2) of the two indices to the three proposed reservoirs on the Damodar system, the following results are obtained." See Table 5.

We have thus been assured that even the existing condition of silt load of the Damodar is not so dangerous as it has often been apprehended on merely looking at the thing. The life of the proposed dams would be further enhanced by the adoption of erosion control measures on the upper catchment areas as mentioned before.

A number of desilting measures and engineering devices have now evolved owing to the increasing

* *Proc. Am. Soc. Civil Engineers*, June 1943.

TABLE 5

CALCULATION OF LIFE OF DAMS BY WITZIG'S FORMULA

Site	Original storate (acre ft.)	Catchment area (sq. mile)	$S_R = \frac{\text{col. 2}}{\text{col. 3}}$	$(S_R)^{0{\cdot}83}$	$\Delta S_R = I(S_R)^{0{\cdot}83}$ I = 1·2	Life of Dam $= \frac{\text{col. 2}}{\text{col. 6} \times \frac{\text{col. 3}}{100}}$
1	2	3	4	5	6	7
1. Parjori on Damodar river ...	345,000	3,000	115·0	51·3	62	185 years
2. Hazaribad or Palkia on Barakar river	463,000	1,665	278·1	106·8	128	228 years
3. Usri on Usri river	59,800	280	213·6	85·8	103	208 years

demand of dams and reservoirs which prove to be great national assets for a country. Mr Brown says

"Since 1900 there has been a phenomenal increase in the number and the scale of such reservoirs in this country (U. S. A.), with an acceleration in construction that was halted abruptly by the war. In 1941 there were on record about 8,900 dams and reservoirs, representing an investment of nearly four and a half billions of dollars. Many of these expensive works were constructed with little or no consideration of the silting problem, and there has been enormous loss of value as a consequence. . . . . Fortunately there is a growing consciousness of the need for sounder engineering practice in designing and maintaining reservoirs. The need to conserve this resource is especially urgent during the war, since we do not have materials and labour for constructing new dams, and yet the demands on existing reservoirs are greater than ever before."

In order to prevent rapid silting up of the reservoirs the following measures are generally recommended :

(*i*) Afforestation and putting selective vegetation at suitable regions of the catchment areas.

(*ii*) Terracing, dyking, etc.

(*iii*) Providing settling basins for smaller streams at the headwaters.

(*iv*) Hydraulic dredging or purging of the reservoir water through the bottom sluices, which scours away much of the sand deposits. This is an old and efficient practice.

(*v*) Mechanical dredging or removal of the debris. This is expensive but becomes more profitable when the deposits can be used elsewhere economically. On the Damodar basin, for example, there is a great demand of sand for stowing the colliery pits: about 20 million tons of sand being required per year in the Jharia coal mine alone. The sand is also used as a building material.

There is already a large traffic on the Damodar for sand required for building purposes at Calcutta and neighbourhood. This already amount to several million tons ; but if navigation by barges can be developed in the Damodar and the Barakar, the traffic in sand can be very extensively developed as in the Ohio river below Pittsburgh (U.S.A.).

"Silting and Sand" have proved 'nightmares' to irrigation engineers, but we are fortunate to live at a time when the large scale experience of thousands of dams constructed in the U.S.A. since 1915 are at our disposal. If we take advantage of this experience, it will be possible 'o construct reservoir dams which will give service for hundreds of years.

Use of the Power

We have indicated above how about 850 million kwh of the electrical energy may be obtained in a year on the Damodar and Barakar systems. People have often asked "Supposing that the power is developed, what can you do with it?" This is like asking the question "What will you do with a gold mine if you can discover it?"

India has so far developed only 9 units of electrical energy per capita per year, while the figure in the U.S.A. is nearly 1500 units. Even a country like Mexico which people regard as a backward country, has developed 180 units per head. This shows the extreme backwardness of India in power-development and this backwardness is the root cause of India's poverty. It can be confidently assumed that if sufficient power is developed, use can always be found for it, and the power will increase the prosperity of the country in the ratio in which it is developed.

As far as Damodar Valley is concerned we can at once indicate immediate use for the power :

At the Coal Mines.—The Jharia coal mines and cities now use about 15,000 kw., or 60 million units a year. This may be obtained from the hydro-electric grid system. This will conserve coal which is a very necessary but exhaustible national asset, and should be reserved for other purpose.

Aluminium.—Chota-Nagpur and other districts of Bihar has the richest deposits of Bauxite. Aluminium can be extracted from this ore if sufficient electrical power is available. The pre-war requirements of India in aluminium was 12,000 tons, and a factory capacity of 4000 tons of aluminium yield per year is an economic proposition. One pound of the metal requires 13 units if electricity for its extraction. A factory 4000 tons will consume $4000 \times 2240 \times 13$ or 120 million units of electricity per year. It is very probable that the consumption of aluminium will go up rapidly after the War and many such factories will be needed. Dr Dunn writes,

"There is no doubt that the bauxite deposit of Bihar will be a valuable asset in future. Although information as to their distribution is well enough, there is no exact knowledge of the actual reserves available. However, the minimum reserves calculated in some of the localities are sufficient to warrant the establishment of industries to utilise this bauxite, and it can be safely left to the companies concerned to determine their own reserves. Further prospecting in these western plateau will undoubtedly bring to light new deposits of bauxite. It is doubtful whether prospection of laterrite in other parts of Bihar will result in finding bauxite deposits elsewhere, but it is certain that high alumina laterites would be found which could be used for certain purposes. The actual development within the province of industries based on these bauxites should be encouraged. All the facilities of coal supply and cheap power are available."[9] (p. 87).

Calcium Carbide.—India needs at present 1000 tons of calcium carbide. Each pound of the gas carbide requires 8 units of electrical energy for its manufacture. The quantity at present is imported from U.S.A., Australia and South Africa. The use of the carbide is increasing with the industrialisation of India. A 500 ton factory will consume 500 × 2240 × 8 or about 9 million units of electricity.

Calcium Nitrate.—Anhydrons Calcium Nitrate is a fertilizer which is extremely good on acid soils like laterites. The raw materials required for the manufacture of the nitrate fertilizer are lime and atmospheric nitrogen which are synthesised with the aid of electricity. There is practically no limit to the demand for the fertiliser. A 35,000 ton plant will require an installed power of 12,000 kw or nearly 90 million kwh. units of total energy in a year, and India's need of nitrate of lime fertilisers is so enormous that even a dozen such factories will not be found too large.

Synthetic Ammonia.—The root cause of famine and permanent malnutrition in India is the low productivity of Indian soil. This appears to be due to depletion of Nitrogen and Phosphorus from the soil of India on account of thousands of years of continuous cultivation without any counterbalacing operation. This subject has been dealt with in an editorial article in SCIENCE AND CULTURE, June 1944, and a subsequent article on "Need and Possibilities for the Production of Synthetic Fertilisers" in the same number.

According to these articles, India needs two to eight million tons of nitrogen annually if her soil is to be raised to the same standard of productivity in paddy and wheat as Spain or Italy. Now, one kilogram of synthetic ammonia requires for its manufacture, according to the latest modification of the Haber Bosch process, 3·6 units (kwh.) of electricity, and two million tons will need 7200 million units, which is double the present output of electrical energy in the whole of India.

A factory producing 24,000 tons of synthetic ammonia may in the first instance be installed in the Damodar Valley, and this will consume nearly 90 million units of electricity. After its usefulness has been tested, more factories may be multiplied.

Smelting of Iron.—The coking coal needed for the smelting of iron in India is limited, and according to experts, the coal will be all exhausted at the present rate of consumption within 30 years, if no fresh source of coking coal is discovered. India will have to fall back upon electricity for smelting of iron, for the production of steel as in Sweden, or San Paulo, Brazil. One ton of iron requires 300—400 units of electricity and if in future, a programme for the production of ten million tons be decided, this will require 3000 to 4000 million units of electricity. Electrical energy is also ideal for the production of alloy steel of all kinds, and there is an immense scope in India for such production.

We have thus indicated that we can not only usefully employ all the electricity which can be produced in the Damodar Valley (1200 million units), but the reader will perceive that this amount is a drop in the ocean compared to the needs of India. Further, coal is an exhaustible asset and should be kept reserved for such purposes for which there is no substitute for it (*e.g.*, preparation of synthetic materials etc.)

Though Indian reserves of coal are rather limited, and quite insufficient for the needs of a country like India, she has got enormous and inexhaustible reserves of power in her rivers. Many of these can be harnessed for the development of hydro-electric power, as we have sketched out for the Damodar, and we understand plans are on foot for the development of similar projects in the Rihand Valley (a tributary of the Son River in the Rewa State, and the Mirzapur district of U.P.), in the Sutleg Valley, and in Mysore or the Koyna Valley in the southern part of Bombay Presidency. Scores of river valleys in India remain still to be surveyed from the point of view of all development, and plans have to be prepared.

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SIR DAVID PRAIN, F.R.S., (1857—1944)

SURGEON-MAJOR, afterwards Lieutenant-Colonel, Sir David Prain, C.M.G., C.I.E., M.A., M.B., I.M.S., D.Sc., LL.D., F.R.S., F.R.S.E., F.L.S., was born on the 11th July, 1857. Sir David took his M.A. degree in 1878, M.B.C.H. (Hons.) in 1883, and F.R.C.S. (Edin.) in the same year and became the demonstrator in anatomy at the Edinburgh University. He then joined the Indian Medical Service in 1884 and officiated for L. J. K. Bruce as Curator of the Herbarium, Royal Botanic Garden, Sibpur, during 1885-86 and subsequently succeeded Bruce as a permanent Curator of the Herbarium in 1886, but his military service prevented him from joining this appointment for about 8 months. He took over charge of the post of the Curator of the Herbarium on the 24th January, 1887. He officiated as Superintendent of the Royal Botanic Garden, Calcutta, during the absence on leave of Sir George King, M.D., K.C.I.E., F.R.S. in 1887. He again officiated as Superintendent, Royal Botanic Garden, Calcutta in 1888 and became Surgeon in October, 1889.

SIR DAVID PRAIN, F.R.S.

During 1889-91 he undertook hazardous botanical expeditions in some of the botanically unknown islands of the Indian Ocean and during his voyage he visited Port Blair in the Andaman Islands, Diamond Island, the Great Cocos and Table Islands in the Bay of Bengal. He voyaged also in H.M.S. *Investigator* and made botanical exploration in the Great Cocos Island, Little Cocos, the Rutland Islands, Narcondam, Barren Island, Little Andaman, Car Nicobar, Batti-malo and other coral islands. In November, 1891, he explored the Pareshnath Hills in Chota Nagpur and in the spring of 1892 he studied the flora of the Khasia and Jaintia Hills in connection with his botanical survey of Assam and Burma.

He acted again as Superintendent of the Royal Botanic Garden, Calcutta from 15th of July to October, 1892 and again for a period of 7 months from 1892 to 1893. At this time for a period of 3 months from 1893-94, he was engaged in an enquiry on the cultivation and use of Ganja—*Cannavis sativa*. On the 1st of July in 1895, Sir David Prain was appointed Professor of Botany in the Medical College, Calcutta in the place of Sir George King and rose to the rank of Surgeon-Major in 1896 and was the foundation lecturer from 1895-96 of the Agricultural Class which was opened at the Bengal Engineering College in 1895. He succeeded in 1897 Sir George King as the permanent Superintendent of the Royal Botanic Garden, Calcutta, who retired after rendering 26 years of devoted and meritorious service. Soon after his appointment as Superintendent of the Royal Botanic Garden, Calcutta, in which post he was confirmed on the 1st March, 1898, he undertook investigation on the cultivation of mustard and wheat and was lucky to discover the host of the wheat rust. He continued his researches on economic plants as well and carried on investigations on the pulses and other leguminous crops by experimental cultivation in the economic section of the Royal Botanic Garden, at Sibpur.

In 1898, Sir David assumed charges of the posts of the Director, Botanical Survey of India and the Superintendent, Cinchona Cultivation, Bengal. He was also appointed a Trustee of the Indian Museum and elected a Fellow of the Calcutta University. He was awarded the degree of LL.D. of the Aberdeen University in 1900. Sir David was a member of the Council of the Asiatic Society of Bengal in 1897 and Vice-President with the late Sir Ashutosh Mukherjee and Sir Thomas Holland in 1904.

Sir David served in the Lhasa Mission and thus got an opportunity of studying the vegetation of the Tibetan frontier during September-October, 1903, and brought back a large collections of valuable specimens. On his return he paid special attention to the improvement of the Royal Botanic Garden, Calcutta, Lloyd Botanic Garden, Darjeeling and the Calcutta Gardens under his charge. Much of the present expansion and improvement of the cultivation of the cinchona plants at Mungpoo is due to

Sir David's care and attention to this section of his work.

After the expiry of his leave on the 15th December, 1905, he was appointed Director of the Royal Botanic Garden, in place of Sir William Thiselton Dyer, another botanist of world-wide fame.

Sir David served as the President of the Botanical Section of the British Association which met at Winnipeg, as President of the Linnean Society from 1916-1919 and as Vice-President and Treasurer of the Royal Society of London from 1919-1929. He was elected as Honorary Foundation Fellow of the Royal Asiatic Society in 1920. Sir David was a active member of numerous Boards and Committees of biological associations and many other scientific bodies where his well-balanced judgment and mature experience made him welcome. He was appointed a member of Tropical Agricultural College Committee by Lord Milner in 1919 and had been the Vice-Chairman of the Imperial College of Agriculture from its foundation in 1921 until 1937.

He was appointed a corresponding member of the Botanical Society of America in 1934 and 1936 and President for life of the Imperial College of Tropical Agriculture in 1938. Sir David became the Chairman of the Plant and Animal Products Council of the Imperial Institute, London in 1936. He sat on the International Committee of Plant Nomenclature that met in 1930 and 1935 at Cambridge and Amsterdam respectively.

Sir David was elected Fellow the Royal Society of London in 1905. He was recipient of C.I.E. in 1906. He received the degree of LL.D. of St. Andrew's University in 1911 ; C.M.G. was conferred upon him on the 1st January, 1912 and was knighted on the 14th July, 1912. He was awarded Barcley Memorial Medal in 1909, the Albert Medal of the Royal Society of Arts for 1925 for the application of Botany to the development of the raw materials of the Empire; the Linnean Gold Medal in 1936 and the Paul Johamer Bruhl Memorial Medal in 1938 and the Barcley Medal again in 1941.

Sir David Prain gained world-wide fame as one of the most active and brilliant botanists by his valuable botanical publications and his scientific investigations which were of considerable value to the State. The total number of his contributions from 1889 to 1944 published in the Annals of the Royal Botanic Garden, Calcutta and many other journals and periodicals in India and abroad comes to about, as far as can be traced, 105 of which about 40 papers were published in the journals and *proceedings* of the Royal Asiatic Society of Bengal. Sir David Prain even before his death was still actively engaged in botanical work and was able to finish his monumental monograph on Dioscoreas in collaboration with Mr I. H. Burkill, M.A., FIL.S., formerly an officer of the Botanical Survey of India. This work entitled "An Account of the Genus Dioscorea in the East" has just been published in the *Annals* of the Royal Botanic Garden, Calcutta, Parts I and II, Volume XIV.

The death of Sir David is an irreplaceable loss to the botanical science.

K. Biswas.

Notes and News

OBITUARY

JAMES McKEEN CATTELL

The death of James McKeen Cattell on January 20, 1944, has deprived America of one of the great organizers of American science and scientists. He occupied a unique position among American men of science and there were few who exerted so profound an influence on American scholarship for a period of about half a century.

J. McKeen Cattell graduated in 1880. He was a student of psychology in which he was deeply interested in the early part of his career. For ten years from 1885 to 1895, he was engaged in research on experimental psychology and published a number of papers which immediately attracted attention. Particular mention may be made of his paper on "Mental Tests and Measurements" (1890) and of the systematic collection of measurements of individuals which won early recognition in the form of a professorship in the University of Pennsylvania at the age of 28. Soon at the age of 31 he became head of the department of psychology at Columbia University. At 35 he was President of the American Psychological Association.

Although a successful professor of psychology, Cattell's fame was made as editor and publisher of scientific journals and organizer of American science in general. He was one of the first American scientists to realize the great power of the press, which he successfully demonstrated throughout his life. In 1894, he acquired the weekly journal *Science* which, under his ownership and editorial management, came to play an important role in the organization of science in America. In the same year he founded, jointly with J. Mark Baldwin, the *Psychological Review*. His success with *Science* led him to take over in 1900 the ownership and editorial supervision of the *Popular Science Monthly* founded by E. L. Youmans in 1872. Later in 1915, he changed its title to *The Scientific Monthly*. In 1907, he assumed control of *The American Naturalist* and in 1905 founded the weekly journal *School and Society*. The latter was one of the leading journals of education, which was afterwards sold to the appropriate body, the Society for the Advancement of Education. He was also a founder of the *Archives of Psychology* and the *Journal of Philosophy, Psychology and Scientific Methods*. He was a trustee of Science Service from its foundation until his death and was president of its board of trustees from 1928 to 1937. "American Men of Science" published in 1906 under his editorship and general directions and followed so far by six editions constitutes his lasting contribution towards the advancement of science in America.

Cattell was made president of the International Congress of Psychology held in America in 1929. In 1921, he founded the Psychological Corporation, a unique organization, to promote applied psychology. He was its president for many years and later the chairman of its board of directors.

THE PERSECUTION OF SCIENTISTS IN ARGENTINA

The recent persecution of Argentine scientists, teachers and professional men for having participated in issuing a 'declaration for effective democracy and American solidarity' has elicited widespread resentment and protest. The declaration was jointly made by one hundred and fifty distinguished citizens of Argentina to give expression to their strong feeling that democracy and human freedom are indispensable for the welfare of mankind and for the progress of science. Among the signatories were some eminent scientists, such as Professors Houssay, Castex, Romano and others. Bernard A. Houssay, Latin America's greatest scientist, is a professor of physiology at the University of Buenos Aires and was awarded the Nobel Prize.

The President of Argentina has found the declaration libellous, although it 'simply approves the principles of democracy and calls for the co-operation of free men in its preservation', and has issued order by which the signatories have been censored and dismissed from their posts in the universities and public services. Medical men have been forbidden to practice. Professors Houssay, Castex and Romano are reported to have taken refuge in Uruguay, on the other side of the La Plata estuary.

Protest against such anti-democratic decree on the part of the Government of Argentina has been made by a number of distinguished scientific organizations of the United States of America, including the American Association of Scientific Workers. In a letter recently addressed to Cordell Hull, Secretary of State, the American Association of Scientific Workers has voiced its protest through the following lines:

"The American Association of Scientific Workers affirms that the existence of such an anti-democratic policy in one of the great countries of the Western hemisphere is a

menace to the welfare of all the peoples in this hemisphere. Recent events confirm our view. Our Association further asserts that the failure of the democratic nations of this hemisphere to condemn officially and to exert pressure to rectify this action of the Argentine Government would be a serious error, first because great injustice has been done, and second because the cause of democratic nations is weakened by ignoring the suppression of liberty and democracy.

Therefore, the American Association of Scientific Workers respectfully but urgently suggests that the Government of the United States of America, in concert with other nations of this hemisphere, take whatever actions may be most effective to the end that the Government of Argentina rescind its undemocratic decrees."

ELECTRICITY SUPPLY INDUSTRY IN GREAT BRITAIN

THE Incorporated Association of Electric Power Companies has recently issued a memorandum with regard to the Electricity Supply Industry in Great Britain. The memorandum refers to the progress of, and development and legislation in, the supply of industry, to the Electrity Commission, and to the work and recommendations of the McGowan, Cooper and Scott Committees, and further contains proposals of reform and improvement with regard to the electricity distribution and the Electricity Commission. The following account of the essential features of the proposals is based on a summary report of the memorandum, published in *Nature*, March 25, 1944.

The memorandum recommends the suspension, through legislation before the war, of the exercise of the rights of purchase by local authorities and others of any electricity undertaking without, however, preventing the completion of negotiations for the voluntary acquisition or amalgamation of such undertakings. The proposed legislation should prescribe the basis of the purchase price to be paid for acquisition of any undertaking. Tariff forms throughout Great Britain should be standardized and the uniformity of charges for the whole country secured as far as it is economically feasible. Legislation should provide in the case of retained undertakers for the application of an effective sliding scale relating prices to costs and charges, including a reasonable return on capital.

Electricity Commissioners should delimit suitable electricity districts and appoint a scheme committee for each district to prepare and submit to the Commissioners a draft scheme for the improvement of distribution in the district. The scheme committee should consist of representatives of the authorized undertakers in each electricity district. Further the Electricity Commissioners should be empowered to make schemes which the Minister of Fuel and Power will have the power to confirm. Any scheme thus confirmed should, however, be subject to the approval of the Parliament.

All retained undertakers should be obliged to submit periodically to the Electricity Commissioners proposals for the development of the supply of electricity for general domestic purposes, including lighting in any part of their area where there is a demand for such a supply and a prospect of a reasonable return from such supply. The Electricity Commissioners should appoint in each area a local committee representative of local authorities and consumers to consult with the retained undertakers on matters affecting development of supplies and prices.

It is considered that the present system of valuation and rating, which has recently excited adverse criticism, should be reviewed. The Association further advocates that the proposed legislation should include various provisions recommended by the McGowan Committee on matters such as the procedure for obtaining wayleaves, fixing wayleave rentals and compensation, public supply of electricity by unauthorized undertakers, and the consolidation of the numerous Electricity Acts into one up-to-date enactment.

The memorandum further recommends the establishment of Electricity Commission whose necessity has become acute in recent years. The Commission should consist of five Commissioners to be drawn from among men of long and wide experience in the industry. The Commissioners should be enabled to appoint an experienced and well-paid staff. The Minister should have the widest choice in appointing suitable men to the Commission. The members of the Commission should not be governed by civil service conditions and rates of pay. An advisory committee should be appointed by the Minister of Fuel and Power to assist the Electricity Commissioners on matters relating to the delimitation of electricity districts and other proposals.

REPORT OF THE INSTITUTION OF ELECTRICAL ENGINEERS

ALMOST simultaneously with the memorandum issued by the Incorporated Association of Electric Power Companies has been published another report prepared by the Post-War Planning Committee for the Council of the Institution of Electrical Engineers. This report has also come forward with a series of important proposals and recommendations concerning the technical aspects of the problems of electricity supply, distribution and installation in Great Britain (*Nature*, March 25, 1944).

The four-wire, three-phase, 400/230 volt system being the national standard for low-voltage distribution, its extension throughout Great Britain has been

suggested as an urgent post-war national industrial plan. The report contains relevant data to show clearly that the problem of complete standardization of low-voltage distribution systems does not present any technical difficulties and assures that this standardization, if undertaken, can be completed within five years. Detailed estimate of the cost, drawn up on the basis of 1939 conditions and price levels, indicates that about £17·5 millions will be required for the purpose.

The report reveals that in 1939, 7·9 million urban dwellings out of 10·7 million, 1·1 million rural dwellings out of 2·25 million and at least 35,000 farms were supplied with electricity. The report recommends that rural electrification should be completed and that financial aid should be provided. Agreement by undertakings on a standard length of underground service cable laid free is recommended. A free overhead service line to a total cost not exceeding that of installing the agreed length of underground service cable is suggested. Simplified and less expensive constructions for high-voltage spur lines are proposed, and agreed standards are recommended. It is to be noted that, unless the consumer is prepared to contribute to the first cost or a subsidy is available, revenue must be adequate enough to justify expenditure on such overhead lines.

The report has made some proposals regarding the establishment of uniformity of tariff forms. Consumers are classified into groups, such as domestic, farm, industrial and commercial, and recommendations are made for the equitable assessment of the fixed or primary charge component of the tariffs appropriate to each group. It is suggested that the Electricity Commissioners should be authorized to permit any undertaking to offer a two-part tariff only, with no alternative flat rate subject to cerain safeguards to the consumer.

The report proposes basic changes in the Regulations for the Electrical Equipment of Buildings. Although the need for compulsory registration of contractors and operatives or for the exactment of compulsory wiring regulations is not at present imperative, extension of inspection of installations by supply undertakings, more general observance of wiring regulations, wider use of the voluntary system of registration of installation contractors, insistence on the use of non-kinkable cords for portable apparatus and the manufacture of accessories and apparatus according to more recent British Standard specifications appear highly desirable.

The memorandum and the report indicate that supply and distribution of electricity have not yet been completely nationalized in Great Britain. The foregoing proposals have been made with a view to introducing more thorough and effective state control of electricity supply and distribution. Much as we appreciate such attempts on the part of distinguished British associations to set their own house in order, we cannot help referring to the hopeless situation in which India now finds herself with regard to electricity supply. Electric companies in India enjoy the privilege of almost unrestricted monopoly and have never cared for consumer's interest which is a superfluous talk in this country. On several occasions the Government was urged upon to introduce effective State control over the production, supply and distribution of electricity, but each time such proposals have been whittled down in favour of the vested interest. The ill-conceived electricity legislations still remain a permanent stumbling block to the natural growth of power and electricity industry in India. In the matter of power consumption India is still as backward a country as Abyssinia or China, despite her abundant power resources in the form of coal and running water. The rate charged per unit of electricity is unusually high, being 3·75 annas (in Allahabad) against 1·25*d.* in England for domestic use. The extent of profiteering is adequately reflected from the amount of dividend the companies declare, which is sometimes as high as 13 per cent. All these are largely due to the unnational policy of the Government and, we are convinced, the evils of monopoly cannot be satisfactorily combated until power production and supply are nationalized.

CENTRAL GLASS INSTITUTE

Sir S. S. Bhatnagar, Director of Scientific and Industrial Research, has announced, at a luncheon given by Mr D. N. Sen, President, Bengal Glass Manufacturers' Association in Calcutta, the decision of the Central Glass and Silicate Research Institute Committee to recommend that the Central Glass and Silicate Research Institute should be located at Calcutta. We learn with satisfaction that the Government of India has sanctioned a sum of Rs. 4,00,000 for the establishment of the Institute. Further, Sir U. N. Brahmachari, Mr I. D. Varshney, of the Central Glass and Silicate Research Institute Committee, and the Bengal Glass Manufacturers' Association have promised to donate a sum of Rs. 10,000 each towards the setting up of the Institute.

THE NATIONAL RESEARCH COUNCIL OF CANADA

Considerable attention has recently been focussed on Canada for her remarkable contribution to the United Nation's war effort and her enviable record of accomplishment in the application of science to

war needs. The credit for this uniquely goes to the National Research Council of Canada, which is acting as the central co-ordinating body directing scientific research in the Dominion. A brief account of the way in which the Council has planned, co-ordinated and conducted scientific research in Canada on problems having a direct bearing on the prosecution of the war has appeared in a recent issue of *Science* (February 4, 1944), to which the attention of our readers may be drawn.

The work of the Council is generally planned along two main lines, (1) the conduct of fundamental and applied research, including essential test work in the National Research Laboratories, Ottawa, and (2) the promotion, co-ordination and support of research in other centres throughout the Dominion by grants-in-aid, award of scholarships and the direction of research investigations under the guidance of committees of specialists appointed by the Council. All investigations, either in its own laboratories or in the laboratories of the universities and industry, are at present directed to the solution of urgent war problems. In fact, the Council is now the official research station of the Army, Navy and Air Force. Scientific problems referred to the Council in connection with the activities of the Armed Forces are studied jointly by officers from Defense Headquarters and civilian personnel on the Council staff.

There are now some forty committees in active operation under the auspices of the Council, through which much of the Council's work is carried on. The Committees on medical research deserve special attention because of their important contributions to the health and well-being of both civilians and members of the fighting services. The Associate Commitee on Medical Research co-ordinates medical research in Canadian institutions and assists in its development. Three Service Committees, *e.g.*, Aviation Medical Research, Naval Medical Research and Army Medical Research, have been brought into existence. Mention may also be made of another important committee which is responsible for the direction and co-ordination of research in Canadian universities on sixty projects dealing with problems on the production of explosives now in use, and the development of new explosives.

The National Research Council of Canada further maintains an effective liaison with the scientific organizations in Great Britain, the United States and other Dominions through the exchange of publications and the interchange of research workers.

THE ROYAL OBSERVATORY AT GREENWICH

NEED has been felt of late for the removal of the Royal Observatory, Greenwich, to a safer and better place where useful work may be carried on under more advantageous conditions. The removal of the Observatory from its present site has been under consideration for the last few years and has now become urgent owing to the damage it has sustained through aerial bombing. The reasons for its removal have recently been discussed in *The Times*, London, by its naval correspondent.

The Royal observatory was established in 1675 and located at Greenwich, a country village well clear of London smoke. For over a period of two and a half centuries it has been responsible for advancement of the science of navigation and nautical astronomy. The meridian passing through its transit instrument has provided the standard of reference in the measurement of longitudes. But Greenwich is no longer situated in a sequestered rural corner suitable for astronomical observations. London has to-day engulfed it and smoke from the chimneys of the newly constructed power stations and the vibration of its reciprocating engines have increasingly come to interfere with its work. The great development of electrical machinery already proved a serious obstacle to accurate magnetic observations, and as such the magnetic observatory was removed some years ago to a country site in Surrey. Such disturbances to-day seriously interfere with the work of the observatory in general. It is strongly felt that unless the observatory is removed to a suitable site, it will be destined to deteriorate into a second rate institution and will fail to play the significant part it did for so long a period. It may be noted that the need for the change of site was stressed by the Astronomer Royal, Dr H. Spencer Jones in 1939 when he submitted his annual report for the year ending April 30. [*Vide* SCIENCE AND CULTURE, Vol. 5, No. 2.]

THE ROCKEFELLER GRANT TO THE NATIONAL INSTITUTE OF SCIENCES, INDIA

Indian scientists will cordially welcome the Rockefeller Grant of Rs. 16,000/- annually to the National Institute of Sciences, India, for financial assistance in scientific publications by the different scientific societies of India. International science owes a great debt to this philanthropic organization for financial assistance in matters of maintenance of research institutes and for grants to scientific societies, an acount of which will be found in SCIENCE AND CULTURE (Vol. VII, No. 1 and Vol. VIII, No. 5). But so far, except in medical matters, Indian science has not received any attention from the Rockefeller Foundation. The present grant which we can trace to the influence of Prof. A. V.

Hill indicates that the foundation has been persuaded to include India within her sphere of operations.

The Royal Society of London receives a grant of £8,000/- from the British Treasury for assistance in scientific publications and distributes this grant through its committees to the different scientific societies of England. In India, we have now national societies in almost every scientific subject, *e.g.*, Geology (1906), Mathematics (1907), Botany (1921), Chemistry (1924), Physics (1934), Soil Science (1934) and Physiology. Some of these have nation-wide membership and scope ; others have as yet only a small membership and influence. But all these societies suffer from paucity of funds and often fail to undertake useful scientific publications for shear lack of money. Regularity in the publication of periodicals devoted to original articles and papers has often become difficult. Clearly, the scientific societies in India are badly in need of financial assistance and more liberal grants. By making this grant the Rockefeller Foundation has earned the gratitude of the scientists of India.

A NEW PUNJAB OIL FIELD

A cable from London to Mr D. N. Wadia from Mr E. S. Pinfold, Chief Geologist of the Attock Oil Co., announces the successful results of the boring tests proving the existence of natural oil (petroleum) at Joya-Mair village, near Chakwal, in North-West Punjab. This area was geologically surveyed in course of his Potwar Survey by Mr Wadia who discovered this favourable oil-storage structure at Joya-Mair and reported it to the Government in 1926, suggesting this area as a possible oil-field in a paper published in the *Records of the Geological Survey of India* in 1929. For fourteen years this discovery remained untested by actual drilling trails.

AN ERRATUM

In line 22 of the left column on page 550 of the June, 1944 issue *read* 0·86 acre *for* 6·86 acre.

SCIENCE IN INDUSTRY

GAS TURBINES

The recent progress in the design of gas turbines has generated the sincere hope that gas turbines are destined to revolutionize power generation in near future. Their great operational simplicity already bears a promise that they will eventually outdo other forms of engines now in use.

At present the reciprocating steam engine, the Diesel and the gasoline engine are generally used for all purposes of power generation. Each of these three different types of engines has its own special advantages and limitations and has accordingly found application in different fields. The reciprocating steam engine is the most inefficient of all these machines, having an efficiency of only 8 to 12 per cent. It also involves a complex and bulky arrangement inasmuch as it requires an auxiliary steam-generator plant. For these reasons steam turbines have so far been exclusively used for the production of large units of power such as are required in ships and central-station electric generators. The Diesel and the gasoline engines are, however, more efficient, so far as power output is concerned, but involve great mechanical complexity. The Diesel engines have an efficiency of about 20 to 25 per cent, while gasoline engines command an efficiency of about 35 per cent. But this advantage in higher efficiency has almost been negatived by the higher cost of fuels and by the extremely complicated designs of the engines. The Diesel has been found suitable for heavier transportation equipment and stationary power generators, but the gasoline engine burning the most expensive 100-octane fuel has so far been applied to drive only light automobiles and aircraft where the saving of weight in engine and fuel is imperative.

The principle of gas turbine was, however, known for several years, but its application was delayed by the absence of a suitable metal or an alloy capable of withstanding high temperatures. The development of gas turbines followed the successful manufacture of alloy steels and other temperature-resistant metals.

The gas turbine is a special type of enclosed multiple wind-mill operated at high speed by hot wind. The hot wind may be directly produced by burning a fuel in a stream of air or may be available as a bye-product, such as the aircraft engine exhaust gases to run turbo-superchargers which compress thin, high-altitude air for aircraft engine. As a bye-

product, the wind may also be obtained in the recovery of power from the burning of deposited carbon from catalysts used in gasoline production Though considerable progress has been made in the design of turbines driven by hot wind obtained as a bye-product from the above sources, further researches are necessary before such turbines can be used as a primary power generator. Design of turbines driven by hot wind and directly produced by burning a fuel has, however, been successfully developed.

In point of efficiency the gas turbine, it appears, will remain inferior to gasoline engine. But its other advantages far outweigh its comparatively low efficiency. The gas turbine presents a far simpler mechanism ; it eliminates the steam turbine's steam generating and condensing system and the gasoline engine's cooling system. Furthermore, the problem of lubricating hot, sliding surfaces does not arise in such turbines. According to a report in *Scientific American*, March 1944, a Swiss oil-burning gas turbine locomotive constructed before the war commanded an over-all efficiency of 15—18 per cent. This is a satisfactory percentage compared with 8 to 12 per cent for a steam locomotive and about 28 per cent for a good stationary steam turbine. Furthermore, as is well-known, the efficiency of gas turbine is proportional to the operating temperature, and as such it increases with the temperature. Thus the turbine which indicates an efficiency of 18 per cent at 1000°F will have an efficiency of 23 per cent at 1200°F. The operating temperature cannot, however, be increased indefinitely and the limit is soon reached. The use of new, non-machineable and non-ferrous metals for the construction of rotor blades has made possible the operation of the turbines at a temperature of 1500°F and higher with the consequent increase in efficiency.

Gas turbines have so far been successfully applied to large power installations. In fact, the technical difficulties in the construction of large gas turbines have been overcome ; but the manufacture of small gas turbines suitable for automobile and aircraft is still frought with several difficulties. Investigations in this direction are, however, on the way and would have been completed but for the war. Recently a committee on gas-turbine-powered locomotives, in its report to the American Society of Mechanical Engineers (*Science, January* 21, 1944), indicated the possibility of constructing a high-powered locomotive in one unit with the prime mover and all accessories in one cab. It appears that this type of power will be used in countries enjoying a reasonable supply of fuel oil. Countries rich in coal but deficient in fuel oils need not be disheartened, as more economic production of fuel oil from coal in future holds out a fair chance of gas turbine locomotives being also used in those countries.

ALUMINIUM FROM CLAY

ECONOMIC production of aluminium from sources other than bauxite has recently occupied the attention of scientists. According to a report in *Science*, March 17, 1944, F. R. Archibald and C. F. Jackson, scientific consultants of the Ancor Corporation, speaking at the meeting of the American Institute of Mining and Metallurgical Engineers, expressed their opinion that aluminium may be economically extracted from clay. High-alumina clay, limestone and coal are three materials required in large quantities for this purpose. Each ton of clay would require about two tons of limestone. Further where coal is not available, other types of fuel may be used. The success of the process has already been demonstrated by a pilot plant in South Carolina, U. S. A., which utilized the Kaolin-type clay available in that State. It is further reported that a commercial plant is now under construction in that State.

Production of aluminium from clay is a significant development. There are regions where all the raw materials needed for the extraction of aluminium from clay are available in plenty and in a high degree of purity, and henceforward production of aluminium may profitably be undertaken in those regions.

COKE FROM PEAT

The Chemical Age, in its issue of February 12, 1944, reported the perfection of a process of making coke from peat at the Central Experimental Station, Moscow. It is claimed that this coke can be used to replace coal-coke in iron and steel manufacture and that it is also a substitute for charcoal. Referring to this report, Fritz Frank, Director of Franks Laboratories, Ltd., has now supplied further information about this process in a letter to the editor of *The Chemical Age*, March 4, 1944.

According to Director Frank, experiments on the process of making coke from peat were successfully conducted in Russia exactly sixteen years ago. The coke was good and firm enough to be used in medium high furnaces for the reduction of iron ore. The iron produced compared favourably with the Swedish charcoal iron in quality. The treatment process in which bog-iron ore was washed and formed with peat was particularly interesting. The peat-iron briquettes thus obtained were very firm. They also dried very rapidly and stood after coking in the tallest furnace available in Russia at that time.

Owing to the war, it is stated, the work could not be further pursued; but good results were reported from time to time from Russia.

The writer further observes that in the metal industry peat-coke has proved superior to charcoal in almost every case because it possesses greater density and an equally high capability of reaction in all cases of metal treatment.

RECENT DEVELOPMENTS IN THE ELECTRON MICROSCOPE

A note on the recent developments in the electron microscope, appearing in *Physics News Letter* issued by the U. S. Office of War Information, draws attention to a paper by V. K. Zworykin and J. Hillier in *The Physical Review*, November, 1943 on this subject.

During the past year, considerable development work has been done on the various optical components of the electron microscope. The effect on the specimen illumination of the electron gun focussing has been calculated. The results show that for some adjustments of the electron gun, the condenser of a conventional microscope exerts practically no control over the illuminating beam. The resolving power of an electron microscope objective has been investigated thoroughly with and without a physical limiting aperture. It was found that for heavy specimen particles the resolving power was roughly twice as good with a limiting aperture as it was without. The best resolving power obtained was 24A. The distortion of the final image caused by the projection lens errors has been investigated, and methods for greatly reducing this distortion have been found. A small magnetic electron microscope has been developed. The resolving power obtained at present exceeds 50A. This instrument uses no condenser lens, while the objective and projection lenses are incorporated in a single magnetic circuit excited by a single regulated current supply. Internal photography is used although, because of the small volume, no air locks are necessary.

INSTANTANEOUS RECORDING

NIRODE BANNERJEE,

RECORDIST, THE HINDUSTHAN MUSICAL PRODUCTS LTD., CALCUTTA

THE shellac prints of the standard gramophone records, the technique of which has been described in a previous article (*Vide* SCIENCE AND CULTURE, June, 1943), are the outcome of a very elaborate and expensive process. It is desirable, for certain purposes, to evolve easier methods by which sound recording can be done in a way such that it may be reproduced immediately. The process for such purpose should be simple enough to be operated by any layman,—it must be quick, inexpensive and sufficiently accurate in the representation of one's voice. It should also be durable enough to be played back a number of times without any loss of the recording quality.

Those who have witnessed the commercial process of recording on wax have marked the fact that recordists usually take a few lines of test of the voice of the artists before final recording. The test cut is reproduced immediately to show how the things will be finally recorded. Thus it is seen that the soft wax discs may be instantaneously played back but it differs in an important matter from instantaneous recording. In the wax, the recorded lines are readily damaged, but in the latter a good many playbacks can be obtained without any damage to the line and loss of recording quality.

DEMAND AND SCOPE OF INSTANTANEOUS RECORDING

There has been an increasing demand for instantaneous recording for various purposes, as noted below:—

(1) *Preservation of voice.*—Many people have the desire to preserve their voice just like their own photograph, and would like to hear the voice of their dear and near ones who have passed away. With the invention of instantaneous recording on discs it has now become quite inexpensive to get a copy of one's recorded voice.

(2) *Use in Schools and Universities.*—Instantaneous recording machines can be easily installed in universities and schools and can be profitably utilized for education. With this machine we can record down pieces of lectures delivered by eminent professors of the day, and these may be reproduced later on at any time we like, to the great pleasures of those who

have missed the lectures directly. Moreover, the exchange of lectures is possible between colleges and universities to the great encouragement of the students. A great demand of instantaneous recording would be found in Blind Schools as well.

(3) *Use in Music Schools.*—Instantaneous Recording has been utilized now-a-days by many music schools in other countries. They are employed both for imparting lessons to the pupils and to save the unnecessary straining of the teachers by repetition and also for demonstrating the defects and merits of the students. This is also an excellent aid to train the voice for any aspiring musician.

(4) *As a tool of research.*—Instantaneous recording is an essential aid to the acoustical researches in the laboratory. Any sound under investigation can be recorded first, and analyzed later on. It may also be employed to record and generate standard sounds and notes for comparison.

(5) *Use in broadcasting stations.*—It is well-known to the readers that all the broadcasting studios have the equipment for instantaneous recording. These are employed either for recording the music of eminent musicians or the lectures of eminent persons or for holding an important broadcasting from abroad which can be played back and rebroadcast from the local stations at convenient hours.

History of Development

The history of instantaneous recording begins with Edison's phonograph which employed wax-drum. The voice was recorded on the rotating drum by the hill-and-dale dentations of the needle attached to the diaphragm at the back of the horn, and reproduced by the same needle and horn. But the lines would not keep intact for sufficient times just like the flat wax discs on our standard gramophones owing to the softness of the material.

Although instantaneous recording on wax and plastics have covered a wide field, attention has been considerably drawn in recent times on the development of the process of recording sound on steel tape by the process of magnetization.

In this type of recording, the steel-tape is the recording medium. The principle consists in magnetizing the tape which runs between the chisel shaped pole-pieces of an electro-magnet. This electro-magnet is energized by the current which is modulated by the pressure of the sound wave at the microphone and later on increased or amplified by the amplifier. With the vibration of the voice at the mike, the strength of the electro-magnet varies, and the passing steel tape is impressed with the corresponding magnetization. This may be called instantaneous magnetic recording. When the steel tape is again drawn between the pole-pieces of the electro-magnet in the reproducing machine, the current in the coil of the electro-magnet receives back the variations which work on a earpiece or loud speaker. The reproduction was poor previously, but by using a film coated with a deposit of iron (as devised by A.E.G.) or steel tapes having a large coercive force (as developed by Lorenz Company), the quality of reproduction has now been greatly improved. The tapes are usually run at a speed of a meter per second and a 50 minutes' recording is now quite possible on tapes. The tape may be demagnetized and used again for a fresh recording. Its principal application is in commercial firms where a busy *entrepreneur* may leave his message to his secretary which may be reproduced later. Some broadcasting stations are also using this type of recording machine.

But modern developments in instantaneous recording are directed towards the disc type which may be electrically recorded and played back immediately on an ordinary gramophone. Pre-grooved metal discs were first tried about the year 1926. The metal was an alloy of aluminium and zinc. The recording quality was very poor and it was suggested to coat the discs with such material as would ensure a soft cut like that on wax with an added advantage of harder lines and grooves.

Since 1928 great advances have been made in instantaneous recording which uses plastics. A large varieties of natural as well as synthetic plastics were tried over metal discs as the record base. The plastics coated metal discs are no longer pre-grooved, but the grooves are cut in the spiral way by some feed mechanism attached with the driving spindle of the recording machine. At first gelatine was tried which produced more or less satisfactory recording quality. But it was rejected as it is soluble in water, dries up quickly and cracks after some time. Celluloid discs were also tried but were rejected as this material is highly inflammable and flexible.

Recent Developments in Acetate Discs

The invention of the coated discs commercially known as acetate discs is the outcome of a great deal of experiment and research. This consists of an aluminium or glass base sprayed with smooth coating of cellulose and other high boiling plasticizers. These coated discs have the following advantages:—

(1) They are non-breakable (when the base is aluminium) and non-inflammable.

(2) They can be played back several times without making any damage to the recorded grooves.

(3) They can be cut by steel as well as by saphire needles.

(4) They can be used for making masters in the processing work for producing hard commercial records which are usually done through wax discs.

After the recording is done the discs are swabbed with a chemical solution to make the grooves harder. The solution consists of 50 parts of a 50 per cent solution of acetic acid to which is added 25 parts of pure alcohol (absolute) and 25 parts of light machine oil. The dope should be applied by means of clean soft rag and rubbed well on the surface after which the disc should be polished with another clean rag. The discs hardened by the dope may be played back at least 70 times in an ordinary gramophone with steel needles.

a high-gained amplifier capable of amplifying that small current into sufficient strength as to work the recording head.

The technique of recording is identically equal to wax recording except the speed of the turn-table which is 33⅓ usually, in place of 78 r.p.m. for standard recording. In addition to this, instantaneous recording is done from inside to outside in place of from outside to inside of standard wax recording.

The question of popularizing instantaneous recording was felt in India few years ago. Production of coated disc at a cheaper cost is one of the important factors in making this type of recording

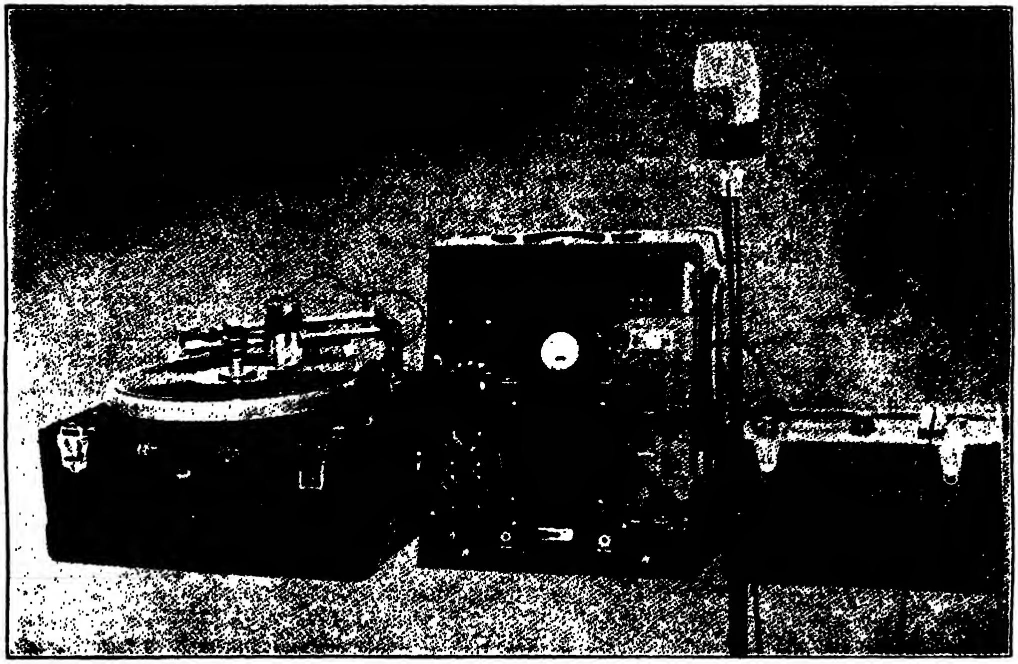

FIG. 1. Presto complete 16" portable recording equipment used the world over by radio stations, advertising agencies, and recording studios for making phonograph records and electrical transcriptions. The equipment is suitable for both studio and field work.

A complete standard instantaneous recording equipment consists of the following items:—

(1) A heavy turn-table driven by an electric motor connected with a flexible coupling device with the turn-table.

(2) A feed mechanism which cuts the spiral lines.

(3) A magnetic recording head and a play-back pick-up.

(4) A high-fidelity type microphone for transferring the sound impulses into electric current and

popular. The standard synthetic discs contain some percentage of nitrocellulose, and the research work which was carried on at the Indian Lac Research Institute under the direction of Dr H. K. Sen was directed to utilize shellac plastics as the chief ingredient. Discs that have been produced at Namkum Laboratory are the same in quality with the other standard discs of the market. The principle adopted in the manufacture of these discs will be described now.

3 lbs. of linseed oil fatty acids are heated with efficient mechanical stirring in a tin-lined copper or enamel kettle to 150°C and 10 lbs. of powdered dewaxed lac (flow not more than 140-150 seconds) added in small lots till intimately mixed. The temperature is then quickly raised to 175-180 degrees and 1·2 lbs. of glycerine is added in a thin stream. The cooking is continued at the same temperature till the acid value comes down to about 40-45 (2½ hours). The mass is now allowed to cool down to about 100°C and dissolved in 1·0 gallon of rectified spirit or redistilled denatured alcohol, and the alcoholic solution run in a thin stream into 2 gallons of distilled water containing 0·8 lbs. of liquor ammonia, (d. 0·88) or its equivalent amount of dilute ammonia.

As freedom from dust and suspended matter is an absolute necessity, the varnish so obtained may first be filtered through finest muslin and then run through Sharple's super-centrifuge. The coating and baking of the blanks must be performed in a dust-free and, if possible, air-conditioned room.

Application to the aluminium of other bases is effected best by spinning on a mechanically driven vertical spindle and flowing the varnish on to the disc from inside to outside. After air drying the disc is baked at 90-95°C for an hour.

The discs are best recorded at least a fortnight after the coating is given, and with a fresh steel needle the surface noise is very little being of the order of about 22 to 24 db below the programme level at 78 r.p.m. and about 20 to 22 db at 33⅓ r.p.m. as against 40 and 36 respectively for other commercial discs under the same condition. With saphire needles the results are still better. The quality of the reproduction compares very favourably with the best imported acetate discs, and the life may be increased considerably by baking the recorded discs at 90-95°C for a few hours.

The discs are usually made of aluminium or glass, and glass gives the best surface to be coated with the recording plastics. Discs have also been manufactured out of shellac—formaldehyde-urea moulding powder. The lac moulded disc has to be baked first at 80°C for about 8 to 10 hours and then at 120°C for about 24 hours, cooled and polished and then used for the coating. (The discs manufactured under this process have been patented under the Indian patent number 29193).

Another improved composition for which patent is being applied for is making use of lac and metallic soaps. Discs produced of this composition has less surface noise and better keeping qualities.

Conclusion

Instantaneous recording represents a further stage of development of recording technique and has the following distinct advantages over wax recording.

(*a*) A commercial wax record has the maximum capacity for accommodating 3 minutes 30 seconds recording, whereas a 16″ instantaneous disc operated at 33⅓ r.p.m. can safely contain 15 minutes' recording.

(*b*) In technical experiments for judging the recording quality of a recording equipment under different recording conditions where a number of playbacks are necessary, an instantaneous disc is more suitable than a wax record as the latter is more easily spoiled with playback.

The instantaneous recording has now become almost as durable, noiseless and accurate as the commercial records, yet added with many other advantages as detailed previously. The technique has received wide attention and is expected to be more widely used in future in various fields.

To popularize instantaneous recordings two things are of primary importance :

(1) Production of cheaper type of discs which may be prepared from some products easily available locally and (2) production of cheaper type of recording machines. Instantaneous recording may be utilized by some enterprising smaller concerns as a source of income by installing a cheaper type of complete recording equipment (at pre-war period a complete recording equipment was available at approximately Rs. 1,000/-) and organizing recording centres where any one can come and record his voice or music at a reasonable fee.

Instantaneous recording on discs has become so popular in U. S. A. and Europe that even the same is done at home, and for its wide circulation it is termed as 'home recording.'*

* The writer acknowledges his indebtedness to Dr H. K. Sen, Director of Indian Lac Research Institute, Namkum, for his very kind encouragement by giving the writer the data and principles of manufacturing these discs and by allowing him to publish the same in the present article. His thanks are due to Mr A. Banerjee, Chief Engineer and Director of Hindusthan Musical Products Ltd., Calcutta for affording him all the facilities to carry on recording works with Instantaneous Recording Machine. He also conveys his thanks to Mr Kamalesh Ray of the Physics Laboratory, University College of Science, Calcutta, for giving his valuable suggestions in preparing the present article.

MEDICINE AND PUBLIC HEALTH

RADIO-ACTIVE ELEMENTS FOR CANCER

CURE of leukemia, lymphosarcoma, plasma cell myeloma, Hodgkin's disease and polycythemia vera by a treatment involving the combined use of X-rays and radio-active elements such as phosphorus, iodine etc. has been reported in a recent issue of *Science News Letter*. Such a combination treatment has been tried on about 100 patients at Memorial Hospital, U. S. A. Chronic lymphatic leukemia is markedly improved as shown by a pronounced diminution in the number of white blood cells whose over-production is a feature of this cancer-like disease. The quality of the red blood cells also improves under the treatment. In cases of lymphosarcoma, there is a reduction in the size of the masses or tumours. Improvement has also been noted in cases of polycythemia vera. Radio-active phosphorus may be given orally or by intravenous injection.

Further, the use of radio-active elements has opened up a new field for the diagnosis of cancer. Radio-activity is induced to elements, ordinarily non-radio-active, by the cyclotron. In one set of interesting experiments, radio-active iodine was used to treat both cancer and benign tumours of the thyroid gland. One of the patients so treated later complained of pain in a small area of his skull. With the help of a Geiger counter the doctor was soon able to detect marked activity at the area where pain was reported, and thus demonstrated the presence of radio-active iodine in that region. It is evident that cancer must have spread from the neck to the head.

The fact that certain tissues are susceptible to specific substances has revealed new clues not only for diagnosis, but also for treatment. Thus, irradiated zinc is deposited in the pancreas, irradiated sulphur in the skin and irradiated strontium in the cortex of bones. Further investigations are, however, necessary before these new evidences can be turned to good use.

CONTROL OF LEUKEMIA

LEUKEMIA is a fatal malignant disease characterized by increased number of white cells in the blood. Dr James B. Murphy and Dr Ernest Strum, of the Rockefeller Institute for Medical Research, have recently made some important studies regarding the possibilities of bringing leukemia under complete control, according to a report in *Science News Letter*.

Their studies indicate that resistance to leukemia is apparently related to the glands of internal secretion. These glands include the pituitary, thyroid, thymus, adrenals and sex glands. It is as yet unknown which of these glands are involved. Knowledge as to the exact nature of this relation is also lacking. Their evidence, however, implicates both the thymus and adrenal glands.

The studies have so far been made with rats. Removal of the adrenal glands greatly reduced the resistance of these animals to a highly malignant form of transplantable lymphatic leukemia. Less than half, 46·9 per cent, of a group of these animals from a strain very receptive to this transplantable leukemia developed the disease upon inoculation, but almost all, 90·3 per cent, of a group of animals of the same receptive strain developed it when inoculated after their adrenal glands had been removed.

The disease in these animals is characterized by extensive invasion of the thymus gland, which, as other scientists have found, is greatly stimulated by loss of the adrenal glands. Lack of these glands and their hormones apparently upsets the normal balance between the various endocrine glands in such a way as to make the animals more susceptible to this form of leukemia.

It is hoped that further work along this line will show what specific glandular imbalance may be responsible for lack of resistance to leukemia. If this can be learned, and if the rat findings apply also to men, it may be possible to find a way of stimulating leukemia resistance so as to prevent or cure the disease.

AWARDS OF LADY TATA MEMORIAL TRUST

THE Trustees of the Lady Tata Memorial Trust announce the awards of the following scholarships and grants for the year 1944-1945.

International Awards for research in diseases of the blood with special reference to Leutaemias have been made to the following workers:

(1) Prof. L. Doljanski, of Jerusalem, to continue studies on (*a*) leucotic cells and agent of fowl leucosis in vitro; (*b*) the X-ray susceptibility of leucotic agent; (*c*) the cell affinities of oncogenic viruses and the mutual relationship between Rous Sarcoma agent and agent of fowl leucosis; (2) Dr Jacob Furth, of American nationality, Cornell Uni-

versity Medical College, New York, to continue the work in progress upon the leucaemias like diseases of fowls and their relation to neoplasms and to determine the nature of viruses producing leucaemias and associated neoplasms, lymphomatosis, myelomatosis. endothelioma, sarcomas, etc., etc. ; (3) Dr P. A. Gorer, Guys Hospital, London, to continue the studies in the genetics of mouse leucaemia: (4) Dr A. H. T. Robb-Smith, Nuffield Reader in Pathology and Morbid Anatomy, Oxford University, to continue the aid to the establishment of a "Lymphonode Registry" in the School of Pathology at Oxford to aim at better classification and follow up of human cases showing progressive hyperplasias and neoplasms of the lymphoreticular tissues including cases of the leucaemias, lymphadenoma, lympho sarcoma, etc. ; (5) Dr Werner Jacobson, part-time Sir Hailey Stewart Fellowship at the Strangeways Research Laboratory, Cambridge, to continue the study of making a histo-chemical study of the argentaffine cells of the gut epithelium, with a view to determining whether they are the source of the intrinsic factor of Castle, and hence their bearing on the problem of pernicious anaemia and other blood diseases ; (6) provisional grant of £400 to the worker under Prof. Witts to confirm Dr Jacobson's research.

Indian Scholarships of Rs. 150/- per month each for one year from 1st July, 1944 for the following scientific investigations having a bearing on the alleviation of human suffering have been granted to the following workers:

(1) Mrs Alamela Venkataraman, Haffkine Institute, Bombay:—Synthesis of sulphanilamide derivatives ; (2) Mr Arobinda Roy, University College of Science, Calcutta: The absorption rate of different edible oils used in India and the effect of Vitamin A and D and hydrogenation ; (3) Miss Violet DeSouza, Indian Institute of Science, Bangalore: The investigation of strains of yeast and other hybrids as sources of the Vitamin B complex ; (4) Mr Narayan Gopal Joshi, Tata Memorial Hospital, Bombay: Vitamin Metabolism in Cancer with special reference to Ascorbic acid and Glutathione ; (5) Mr P. K. Bhattacharyya, University College of Science, Calcutta: Investigations on anti-bacterial substances produced by moulds ; (6) Mr S. Dattatreya Rao, Indian Institute of Science, Bangalore: Investigations on the influence of tocopherol and fat on the absorption and utilization of Carotene and the function of Carotene in the animal system.

PENICILLIN IN INDIA

We learn with satisfaction that penicillin, the new drug which is one of the major discoveries of this war, is now being produced in Bombay. Working in close collaboration with British and American scientists, the staff of the Haffkine Institute, Bombay, under the supervision of Col. Sokhey, Director of the Institute, are growing small cultures of penicillin mould under low temperature. From these penicillin in its pure state will later be extracted.

PENICILLIN

A. C. UKIL

CALCUTTA

Though immediate credit for the discovery and development of Penicillin as a powerful therapeutic remedy against certain bacterial infections goes to a batch of British workers, the clues were obtained much earlier. As early as 1877, Pasteur and Joubert noticed the inhibiting action of some bacteria on the growth of others, which led them to hope that some day important therapeutic applications might ensue from these phenomena. Since then workers had noticed these phenomena while studying bacterial cultures and even tried to apply them clinically in certain groups of cases.

In 1929, Prof. A. Fleming noticed a green mould growing as a contaminant on an agar plate which he had used for the cultivation of staphylococci. He noticed that in the neighbourhood of the mould the colonies of staphylococci were dissolving. The contaminant was identified as *Penicillium Notatum,* belonging to the genus Penicillium, so called from the resemblance of its fruiting body to a pencil or brush. On growing this mould in a liquid medium (peptone broth), Fleming noticed that it secreted something into the medium which inhibited the growth of many pathogenic bacteria even in high dilutions. Fleming gave the name Penicillin to this antibacterial agent. He also noticed that it was not toxic when injected into animals and that leucocytes were very little affected by it. The crude penicillin was, however, found to be very unstable and was too weak and too crude for injection. Early attempts at concentration were not successful and attempts at clinical trial were not pursued.

In 1932, Clutterbuck, Lovell and Raistrick found that penicillin was formed when grown on a synthetic culture medium, that it was a very labile substance, that concentration of the culture medium at 40°C. *in vacuo* inactivated penicillin, that it could be extracted from the culture medium with ether after acidification and that the greater part of its activity was lost on evaporation of the ether solution in a stream of air.

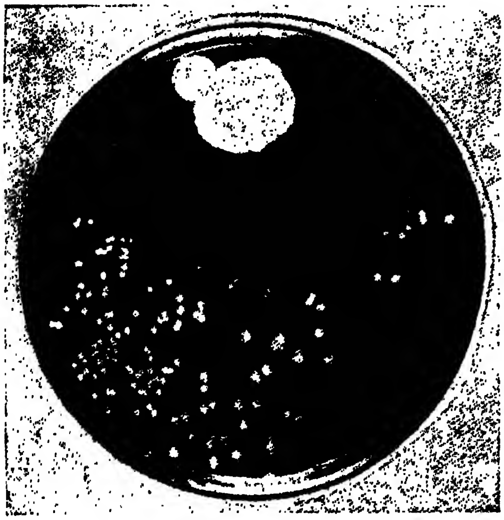

FIG. 1. The picture shows the original culture plate on which Prof. Fleming, in 1929, observed the mould *Penicillium Notatum* growing. The bacterial colonies round the mould can be seen in a state of advanced disintegration owing to the presence of Penicillin, while the colonies furthest away are still flourishing.

In 1938, E. Chain and H. W. Florey became interested in a study of the chemical and biological properties of anti-bacterial substances produced by microbes, and luckily one of the first of such substances to be taken up for study was penicillin. They attempted to find out the chemical nature of the biologically active agent. It was soon established that penicillin was an acid of low molecular weight, soluble and stable in various organic solvents, but stable in water only between pH 5 and 7. It was found that penicillin could be extracted into ether at an acid pH and that it could be re-extracted from the ether solution into water in the form of its salts by adjusting the pH to neutrality. It was also found that during these operations no loss of anti-bacterial activity occurred as long as the solutions were kept cold. Chloroform and amyl acetate are now used for the extraction and purification of penicillin on a large scale. On evaporation of the watery solution *in vacuo* from the frozen state, a dry penicillin salt preparation was obtained which retained its activity for a long period. The initial crude preparations contained only about 1 per cent of pure penicillin, but even these inhibited the growth of staphylococci and other bacteria in a dilution of 1 : 500,000, an effect similar to that of powerful antiseptics like actriflavin.

The anti-bacterial activity of penicillin is expressed as the amount of penicillin which is contained in 1 ml. of a certain purely arbitrary stock solution. This is known as the "Oxford Unit". A rough indication of the size of the unit will be had when it is stated that pure penicillin contains about 1,000 units per milligram and that most strains of staphylococci are usually inhibited by a concentration of 0·01 to 0·05 units per millilitre, or with highly purified preparations of penicillin, the growth of staphylococci and streptococci is prevented at dilutions between 1 : 50,000,000 and 1 : 100,000,000.

It was evident that with such an anti-bacterial substance having low toxicity and high bacteriostatic action, further studies should be directed (1) to arrange for large-scale preparation, as the culture contained only small quantities of the product, (2) to purify penicillin and to study its chemical nature, and (3) to make a study of its biological properties. This was made possible by a team of workers, chemists, bacteriologists, pharmacologists, technologists and clinicians, prominent among whom were like E. Chain, H. W. Florey, M. E. Florey, N. G. Heatly, A. D. Gardener, E. P. Abraham, R. V. Christie, H. V. Morgan, R. Mowlen, L. P. Garrod, C. M. Fletcher, G. Glister, K. Callow, Mahony, Arnold, Harris, Herrell, Keefer and others.

A synthetic medium to which yeast has been added was used for large-scale preparation at 24° C. As different strains vary in their potency, special care is needed to select a non-toxic strain which will yield the largest yield. The yield of penicillin from a 20-litre culture fluid is only one gramme. In 10-14 days, the fungus grows rapidly and covers the surface of the liquid medium. The liquid substance of the medium turns yellow and contains penicillin. The crude penicillin, although fairly stable, contains mixtures of very many different substances. The isolation of penicillin from this mixture proved to be a difficult problem, because of its instability towards many chemical reagents and of the unfavourable solubilities of the free acid and its salts. By a suitable combination of distribution between solvents, chromatographic methods and a reduction process by aluminium amalgam, it has been found possible to obtain barium salts possessing an activity of about 1,000 Oxford Units per milligram. Recently, it has been possible to obtain crystalline praparations of salts of penicillin. Work has also been done to determine the constitution of the breakdown pro-

ducts of penicillin, and this may open the way to its eventual synthesis. Workers in America and other countries are actively engaged in pursuing the subject. Chemists are expected to play an important part in the next phase by grouping its molecules, as has been the case with sulphanilamide.

The purest preparations of penicillin have been found to inhibit the growth of staphylococci at a dilution of 1 part in 50 millions. Gonococci and meningococci were found to be twice as sensitive as staphylococci. Among other bacteria which have been found to be sensitive are streptococcus, pneumococcus, anthrax bacillus, diphtheria bacillus, some strains of *actinomycosis* and the important group of gas gangrene organisms like cl. tetani, cl. welchi, cl. vibrion septique and cl. oedematiens. Recent work done in the U. S. A. shows that intensive treatment with penicillin cures the primary sore of syphilis. The typhoid-dysentery group of bacilli is among those which are less sensitive. The coliform group of organisms, *B. Proteus, B. pyocyaneus,* the genera *Haemophilus* and *Brucella, Streptococcus* faecalis and tubercle bacillus are insensitive.

The body deals with infecting organisms largely by means of the leucocytes—mobile agents which ingest and kill the bacteria. With increasing purification of the penicillin, its low toxicity has been further reduced and it has been found by tissue culture and leucocyte suspension experiments that the tissue cells retain their activity with fairly high doses and that no toxic effect is observed on the blood-pressure, heart-beat, or respiration of cats, when doses sufficient to produce anti-bacterial concentration in the blood are given to them. It could be injected directly into the brain and cerebrospinal fluid of rabbits without toxic symptoms. The anti-bacterial activity, which is not influenced within wide limits by the number of bacteria present, is in no way diminished by blood, pus, tissue autolysates, or protein hydrolysates. Very little destruction takes place inside the body as it is largely excreted by the kidneys. Penicillin, even in strong dilutions, does not kill the bacteria immedately, but inhibits their growth. These facts and its insensitivity to the products of tissue decomposition give penicillin important advantages over the sulphonamide group of drugs, which do not act effectively in the presence of protein breakdown products or if large numbers of bacteria are present. As with sulphonamides, the action of penicillin is bacteriostatic rather than bactericidal, the actual destruction of the bacteria being done by the body cells. The best results are observed in cases with good phagocytosis and high immunity, *i.e.* where the blood supply in the infected tissue is good and tissue metabolism efficient. With most new drugs, the upper limit or tolerance is determined by the occurrence of toxic symptoms. With penicillin, striking therapeutic effect is produced by doses far below the toxic level. These facts combined together would make penicillin a chemo-therapeutic remedy of first-rate importance.

Penicillin has been found to be rapidly absorbed after intramuscular or subcutaneous injection, but

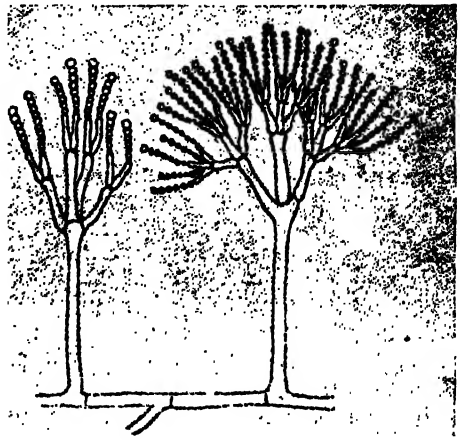

FIG. 2. The above is a drawing of the mould penicillium. The bluish-green colour of this common mould, which occurs on almost every sort of organic matter, is due to a dust of the asexual spores by which it is propagated. A branched mycelium penetrates the substratum, and sends up reproduction branches into the air, on the tips of which are chains of small rounded spores that are freed by the faintest touch of air.

not after oral administration, since it is destroyed by the hydrochloric acid of the gastric juice. It is, however, absorbed from the small intestine, but enzymes from the coliform bacilli present in the large bowel destroy it. It is excreted into the saliva, urine and bile, but does not pass freely from the blood-stream into the tears and pancreatic juice and cerebro-spinal fluid. It can also be safely administered in severe cases of generalized sepsis, by the intravenous route. It is destroyed by acids and alkalies, by boiling, by heavy metals such as copper and lead, by oxidizing agents and by enzymes from many common bacteria, including some air bacteria and some members of the coliform group. Many organisms which become sulphonamide-resistant are penicillin-sensitive, although experiments have shown that certain organisms may become penicillin-resistant. Local application has also proved to be effective in lesions caused by penicillin-sensitive organisms, provided penicillin in sufficient concentration gets access to all infected areas caused by injury or otherwise.

The potentialities of a remedy with a great anti-bacterial power combined with low toxicity are

indeed great. The only difficulty militating against its widespread application at the present moment seems to be the low yield of the material. This will perhaps remain so until chemists can help in the synthesis of the active material. This development is urgent, particularly because penicillin and its preparations cannot be stored without loss of potency for more than 3-6 weeks.

Having reached this stage, British workers of the Sir William Dunn School of Pathology at Oxford, field workers in the various war zones and American workers devoted their attention to finding out the routes of administration and the minimum effective dose in various groups of cases. A reasonably stable sodium and calcium salt of penicillin was prepared, the sodium salt proving to be hygroscopic. These salts were found to be extremely soluble in water. The potency has varied from 6·8 to 160 units per milligram of different samples of the product. The calcium salt is unsuitable for intramuscular or intravenous injection in strong solutions.

For *local* application, three preparations have been used to treat different types of lesions: (1) solution in water in a strength of 250—500 units per c.c.; (2) emulsion cream, made of lanette wax SX—33 per cent, vaseline—33 per cent and water to 100 per cent making a final strength of 100 units per gram; (3) powder, in base made of 95 per cent of sulphanilamide and 5 per cent of light magnesium oxide, which are sterilizable by autoclaving. For a successful result, it is necessary that the primary infecting organisms must be penicillin-sensitive, it must reach all parts of the wound in an effective concentration throughout the period of treatment and that treatment must be continued until organisms cease to be cultivated or sometime after apparent clinical cure. It has been tried successfully in infections of the eye, skin, mastoid process, chronic wound sinuses, abscesses, empyemata, burns and miscellaneous local septic conditions. In infections contaminated with *B. pyocyaneus*, *Proteus* and *B. coli*, penicillin does not act well until the pus is drained. The accessibility of tissues to the action of penicillin is an important consideration in treatment. Much smaller doses are needed for the treatment of local conditions than in systemic infections where injections are imperative.

For reasons stated above, unlike sulphonamides, penicillin cannot be administered *orally*.

The most practicable method of administration is by the *intramuscular* route at 3-hourly intervals of a dose of 15,000 Oxford units, although it may vary according to the type of case. Owing to the rapid elimination of the drug by the kidneys, repeated injections are needed. At the end of the 3-hour period after injection, a careful examination of the serum should be made to see that the serum is still fully bacteriostatic. The pain caused by the injections can be minimized by adding novocain to penicillin solution at the time of injection. A total dosage of 5,00,000 to 1,000,000 units may be needed in severe cases. In estimating clinical progress, the temperature chart is a poor guide. Attention should be focussed to other criteria, such as lessening of pain, reduction of swelling and pus, improvement of appetite and sense of well-being, in addition to the data obtained from bacteriological examinations. The most striking result, however, has been the rapid restoration of function and the completeness with which function is regained, as compared with cases which have not received the benefit of penicillin therapy.

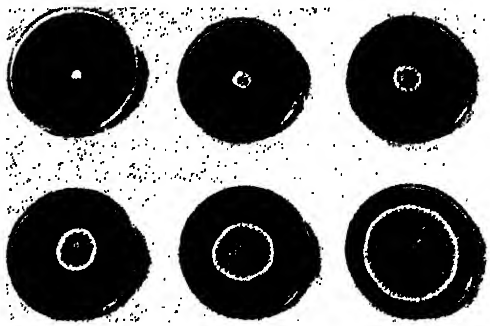

Fig. 3. The white crinkled part is the mould which exudes Penicillin into the broth (the black part), in which it grows. From left to bottom right the rate of growth is shown from one to ten days.

Apart from the conditions described above, penicillin therapy has been found to produce good results in generalized or localized staphylococcal or streptococcal infections, chronic sinuses, abscesses, empyemata, cellulitis, arthritis, acute mastoiditis, acute, subacute or chronic osteomyelitis, sulphonamide-resistant streptococcal meningitis, cavernous sinus thrombosis, carbuncle, anthrax infections and some cases of actinomycosis. Penicillin is the chemotherapeutic agent of choice in the treatment of gas gangrene, when given as an auxilliary to radical surgery and gas gangrene anti-toxin, the latter helping to neutralize the toxin from gangrenous muscle where penicillin cannot act. It has also been found in America to bring about a radical cure of sulfa-resistant gonorrhoea and gonorrhoeal arthritis. Endocarditis caused by *streptococcus viridans* was, however, found to be ineffective. Recent work in America indicates that a radical cure of primary chancre in syphilis may be obtained by intensive treatment with penicillin.

In cases of staphylococcus septicaemia and pyaemia, *intravenous* administration, along with intramuscular introduction, a complete cure has been reported even in very severe cases. No toxic symptoms due to the drug have yet been met with.

For intravenous administration in serious cases, drip transfusion has been found to be useful. For this purpose, 30,000 units of sodium penicillin are dissolved in 1 pint of 4 per cent dextrose in 0·18 per cent saline, taking 6 hours for transfusing this quantity. The advantage of continuous intravenous transfusion have been found to be continuous maintenance of adequate blood titre and the disadvantage is frequent and painful thrombophlebitis, rendering many of the veins useless for further injections.

The advantage of intermittent intramuscular injection is its simplicity but its disadvantages are (1) pain, and (2) disturbance of the patient every 3 hours. Its administration by drip transfusion into bone marrow has been tried with a certain degree of success. A continuous intramuscular drip transfusion of penicillin has been tried with success in some cases. This has the advantage of maintaining an adequate blood titre, avoiding repeated punctures and comparative freedom from pain, but it has a tendency to local infection and abscess formation. In conducting successful treatment, it is necessary to have adequate laboratory control in not only making the initial correct bacteriological diagnosis but also in checking the results of treatment by estimating the penicillin content of blood and of exudates. A recent issue of the *British Medical Journal* (April 15, 1944) contains as many as 8 papers on therapeutic trials in various types of cases carried out under the guidance of the Medical Research Council in England.

From what has been said above, it will appear that the application of penicillin sufficiently early in a large number of diseases where the infective organism is sensitive to penicillin may dramatically alter the whole picture. It is striking that such a remedy has been obtained from an initial accidental discovery. The chief difficulty at present is its production in sufficient quantities. It is desirable that strains of *Penicillium notatum* should be obtained from Oxford and work started in India in accredited laboratories. Extensive investigations should also be carried out to see if any other mould produces a similar or better remedy. Chemists should also get themselves busy with chemical work with a view to eventual synthesis. Unfortunately the tubercle bacillus still remains outside the fold of chemotherapy.

It is gratifying to note that the Rockefeller Foundation offered its help to the British workers to conduct their researches. In conformity with the Foundation's traditions, it is hoped that it will now stimulate the production and control of penicillin in other countries of the world. By so doing, the Foundation will help in reducing unnecessary human suffering from many infections in different parts of the world.

BOOK REVIEWS

British Dramatists—By Graham Greene. Published by William Collins & Co. Ltd., London. Pp. 48.

The book under review belongs to the brilliant series known as "Britain in Pictures". It tells within a very short compass and in a singularly lucid and graceful style the story of the growth and development of British drama from the *Mystery* and *Miracle Plays* to Eliot's *Murder in the Cathedral*. It is indeed amazing that the author has been able to mention all the important phases and characteristics of English dramatic literature in a small book of forty-eight pages. The transition from one form of drama to another has been very clearly shown. The author has also pointed out the anticipations of later drama in the mediaeval plays. The need of utmost compression has not prevented Mr Greene from putting a few words about stage-craft and theatre houses.

The fine critical acumen of the author which is manifest in his pithy observations on the genius and achievements of the different dramatists is likely to form and influence the taste of the readers. The book is, as such books ought to be, something more than a mere chronicle of literary events. It expresses the impressions of a sensitive and critical mind which make it very pleasant reading. It does not raise any controversy, nor does it simply repeat the common place formula of standard criticism. The statements of Mr Greene have a freshness and vigour which would surely create in his readers a strong desire for studying the dramatists for themselves. The book contains eight plates in colour and twentysix illustrations in black and white which are very excellently produced. This double attraction of the brilliant essay and a nice album have made the book

an invaluable possession for those who are interested in the subject.

R. K. D. G.

Art of Discipline and Leadership or How to maintain Discipline and attain Leadership.—By ABUL HASANAT (Indian Police), Pp. 1-306, published by the Standard Library, Dacca. Price 3*s*. 6*d*. or Rs. 2/4.

The subject matter is dealt with under the following chapter heads (1) Discipline—Why necessary? (2) What is discipline? (3) Sphere of Discipline—Whose and When? (4) A deep driving desire, (5) The right disciplinarian, (6) Self-confidence, (7) Fearlessness, (8) "Obey-me" attitude, (9) Manner—How to conduct oneself, (10 and 11) Tone—How to order others, (12) Sense of proportion, (13) Supervision, test and inspection, (14) Justice and discrimination, (15) The magic appreciation, (16) Appropriate handling of human nature, (17) Chart Index, besides a very large number of sub-headings. The author's delineations though made in popular style are fully comprehensive and are to the point. The performance reflects great credit to the author who has displayed a very wide reading and critical aptitude and vast experience. It is really a good book on a very important topic of Social and Industrial Psychology, which is claiming the attention of the military authorities and managers of big workshops and factories who are in search of people endowed with some amount of leadership. Any one concerned with the maintenance of discipline and retentions of leadership is likely to derive much benefit from a perusal of the book. The author has relied principally on biography of great men and has discussed some psycho-analytic complexes with a view to emphasize the primary wishes to achieve one's ends. He would have done well to have discussed the importance of tests of temperament and character traits of a personality with a view to the selection of leaders for different tasks. Though much can be done to evolve leadership where it is inherent yet modern psychology does not believe in creating leadership in one where it is lacking. Leadership is really inborn and thrives in proper environment. Discipline can be taught and maintained by training proper methods.

M. N. B.

Soviet Russia—Edited by K. S. HIRLEKAR. Published by Avanti Prakashan, Bombay. Price Rs. 6/8.

The book under review is a collection of articles by Academicians, members of the Supreme Soviet and prominent Soviet workers engaged in active work in various branches of science, industry, agriculture, education, transport and communication and such other fields of human activity. The articles, written as they are by men who have first hand knowledge of men and things in Soviet Russia, have a stamp of authority and an importance which need hardly be overestimated. Some of these articles were written in 1939 for the visitors of the Soviet Pavilion at the New York World Fair and already published in various foreign papers, while others appeared at different times in Soviet daily newspapers, such as *Moscow* and *Soviet Russia Today*. Mr Hirlekar to whom goes the credit of editing and compiling these articles has shown real skill and knowledge of affairs in Soviet Russia in his selection of articles. There are far too numerous writings on Soviet Russia to indicate in superlative terms the colossal progress U.S.S.R. has made in every sphere of national development, but few have sought to corroborate the real extent of this progress by reliable statistical data which alone make the statement of any use. Mr Hirlekar has taken particular care in choosing articles replete with statistical information and has himself supplemented it by a series of useful appendices.

The book has been divided into five parts devoted to (1) Soviet Russia—Economic Power and Resources, (2) Soviet Industry and Communications, (3) Soviet Agriculture, (4) All-round Contribution to Industrialization and General Uplift, and (5) Soviet Russia, 1940-43. It is satisfactory to note that logical sequence in the arrangement of articles has been maintained throughout. Through these articles the story of the phenomenal development of natural resources, their utilization through the establishment of light and heavy industries, the growth of an admirable system of transport and communications on land, through air and along waterways, connecting the far-flung and hitherto inaccessible parts of Russia, the spectacular success of Soviet agriculture through the institution of State and collective farms and application of modern methods of science, the cultural revolution through the liquidation of mass illiteracy, the remarkable increase in the workers' efficiency through the Stakhanov movement and such other Soviet developments during the last two decades has been told in a lucid, accurate and fascinating style characteristic of the Soviet writers. The incorporation of four maps showing the Constituent Union Republics, the location of basic heavy industries, and of paper and saw mills and the chief air lines has further increased the usefulness of the book. Mr Hirlekar must be congratulated for having edited such a book which, we hope, will be cordially welcomed by every one interested in Soviet Russia as well as by general readers.

S. N. S.

Habit and Heritage—By Frederick Wood Jones, D.Sc., F.R.S., Professor of Anatomy, University of Manchester. Published by Kegan Paul, Trench, Trubner & Co., Ltd., London, 1943. Pages 100 with 17 illustrations. Price 5s. net.

In this well written book Prof. Wood Jones has advocated the idea of inheritance of acquired character, which has remained since Lamarch postulated his doctrine about a century ago, a subject matter of heated controversies. It is a vital question in the complex problem of heridity and biclogists all the world over have tried to solve it. Heckel, de Vries, Buffon, Darwin, Wallace, Weismann, Herbert Spencer, Roux, Doncaster, Bergson, Arthur Thompson, Haldane to name a few, have all put forward evidences and discussed the problem, whether a character or modification acquired by an individual in its life time, can be transmitted to its progeny, and thus become a factor in evolution. It is an important factor, as the acquired character may be either beneficial or detrimental to him and his race and thus contribute largely to its evolution.

The genes within the chromosomes are the bearers of almost the whole hereditary constitution, which is fixed for the race and are handed over from parents to offsprings. But it is also an undoubted fact that mutants or "fricks" (with actual alteration in some of the genes and not mere shifting of the old ones) appear, having characters different from the parents and that these mutations are inheritable.

An equally important question is whether environment to which living objects react and adjust themselves to its changes, play any part in evolution. Are the modifications acquired by an individual in its life time in response to environmental changes inheritable?

A considerable amount of controversies have taken place to explain what is meant by "Acquired Characters", which have only caused confusion and Prof. Wood Jones has devoted an entire chapter to it. The modifications are acquired or developed by actual use or disuse in response to physiological adjustment to the environmental changes and not a mere accidental injury and "several generations must be subjected to changed habits for any appreciable result. The incorporation of these changes in the physiological or anatomical make up of the race, the inheritance of which has a physical basis in the germ plasm, must necessarily be a slowly developing process. The author has set to answer the question: May a feature developed repeatedly during the successive lives of a long series of generations be ultimately incorporated in the heritage of the Species as a permanent feature?

It is difficult to demonstrate such inheritance by experimental methods but Nature with unlimited time at its disposal may furnish evidences of its actual happening. The author has considered in detail several instances from Nature, where some particular modification developed in response to some special condition has become permanent in the race.

The special facets on the libia and astragalus in some of the squatting races (the Punjabis), who for generations have habitually taken up a peculiar squatting posture, is quite different from the facets developed in the Australian aborigines who assume quite a different squatting posture. These facets have become permanent and are present in the embryo as an inherited characteristic. The same story is found in the peculiar spinal curvature in the seal embryo and in the reversal of the hair slopes in some of the marsupials. In the chapter on the highly interesting method of reproduction in the marsupial the author has tried to demonstrate the gradual incorporation, as an inherited adult permanent structure in the higher order of these animals, the better elaborate primitive birth passage, which is just a very temporary arrangement in those of the lower order.

B. B. S.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

SPACING RATIO OF ATMOSPHERIC STREETS

In a slow moving stream two rows of vortices appear in the wake behind a moving bluff obstacle. All the vortices are equally spaced and equally strong, so that a clockwise (negative) vortex, for example, is symmetrically placed between two anti-clockwise (positive) vortices. There is an 'axis of symmetry', directed downstream, between the row of negative and of positive vortices. The vortices to the right of the axis are negative and to the left, positive. The line cuts symmetrically the sinuous stream of circulating fluid between the two rows of vortices. This is the wellknown Kármán street which is a vortex street with two rows of vortices. The spacing ratio of a street is the ratio of the distance b separating the two rows of vortices to the spacing a of two consecutive vortices of the same sign or, the wave length of the street.

The method of forecasting by fields and streets is based on the 'theory of free streamlines' of Helmholtz, Kirchhoff and Rayleigh. In the spacing ratio, the theory provides an index of the aerodynamical stability of a street, and, therefore, indirectly of that of a 'cyclic field' which may appear between two streets from opposite directions. The stability criterion of a street has been fully worked out in treatises on aerodynamics and a Kármán street is found to be stable for all disturbances when the spacing ratio is 0·3.

The spacing ratio of an atmospheric street is of considerable help to the forecaster in deciding such issues as the persistency of a type of weather, the potentialities of cyclonic and anticyclonic disturbances and the formation of cols and squall fields. The cols are often responsible for sudden and unexpected weather, generally of a 'sporadic' nature and sometimes of great intensity.

The earth, in the 'general circulation' of the atmosphere, resembles a sphere rotating about a crosswind axis. The orographic reliefs are the fixed, three-dimensional bluff obstacles. As to the analogy of an undisturbed stream striking an obstacle, the dominant orographic relief of the American continents, stretching from one hemisphere into another, are ideally placed in the (undisturbed) *primary* easterlies U_E and westerlies U_W, of the 'general circulation'.

The streets, associated with the normal positions of the two primary streams in each hemisphere, produce the two great families of anticyclogenesis fields, *viz.*, the field A echelons[1] in the northern hemisphere and field B echelons in the southern hemisphere. The anticyclogenesis fields are therefore the normal fields of the 'general circulation'.

Incidentally, it is the local and short-lived reversal of the normal positions of the easterly and westerly streets in the same hemisphere that brings the cyclogenesis field into existence. In the monsoon, however, the reversal is long-lived and represents persistent interactions between two hemispheres. Consequently, the highest frequency of cyclones in the Bay of Bengal is registered in this season.

Rockies in the northern hemisphere are approximately parallel to the dilatation axes of the field B family echelon, whilst Andes in the southern hemisphere are parallel to the dilatation axes of the field A family echelon. These are the two great cyclogenesis fields in the respective hemispheres. In other words, the orographic reliefs act as dilatation axes and promote transport of heat between high and low latitudes.

The average layer of the atmosphere affected by the mountain ranges is at least 5-6 km. in thickness. It is noteworthy that the thickness of the 'generative shell' in the Indian area is also of this order in the monsoon. Anticyclogenesis commences at the top and cyclogenesis at the bottom of the generative shell.

The bluff obstacles, Rockies and Andes placed in U_W, deflect the current and thus shed high pressure vortices to their west in both the hemispheres. During the monsoon, the anticyclone to the west of the Western Ghats illustrates the bluff obstacle effect in the Indian region. Similarly, low pressure vortices are shed by orographic relief suitably placed in U_E or U_W. It is between these high and low pressure vortices of the same undisturbed stream that the sinuous stream runs.

The analogy of the Kármán street with the atmospheric vortex street seems irresistible. The distinguishing features of the latter are:—(*i*) the mode of formation, (*ii*) the appreciable solid rotation cores of the vortices of the street and (*iii*) the geographical scale of the bluff obstacles.

The isobaric charts and the streamlines aloft demonstrate that the atmosphere consists of two types of vortex streets, *viz.*, (*a*) single row of vorticles and (*b*) double row of vortices. It is apparent that, with

the weakening of the undisturbed streams, a diffusion of an anticyclogenesis field echelon will leave only the 'sources' (which are the high pressure vortices) prominent and, as is to be expected from the normal dispositions of U_W and U_E, this feature is emphasised in the average charts.

For example, the annual average isobars at sea level over the globe show a row of marked source vortices (subtropical anticyclones) with diffused low pressure areas on either side in the subpolar and equatorial regions. The prevalence of convective instability in these regions is well-known. The stream-lines in the average wind fields in the directive shell over the Indian region[3] also bring out the same features.

In the determination of the spacing ratio of a street of double row of vortices, both *a* and *b* have to be measured from the weather charts. The former, taken as the wave length of the street, is easily estimated from the weather charts. It is of interest to note in passing that air masses may often be identified by the wave length of an undistorted and simple street of a spacing ratio of 0·3.

In actual practice, the streets are often distorted and complex and especially so in the transition months. Some of the disturbing factors are:—(*i*) orographic relief, (*ii*) periodic motions which displace the vortices at right angles to the streets, (*iii*) fluctuations or weakening of the undisturbed streams, (*iv*) anticyclogenesis and cyclogenesis in the field, introducing longitudinal expansions or contractions in the cyclic fields, (*v*) unequal turbulance over land and sea, and (*vi*) fracture in the col field, etc.

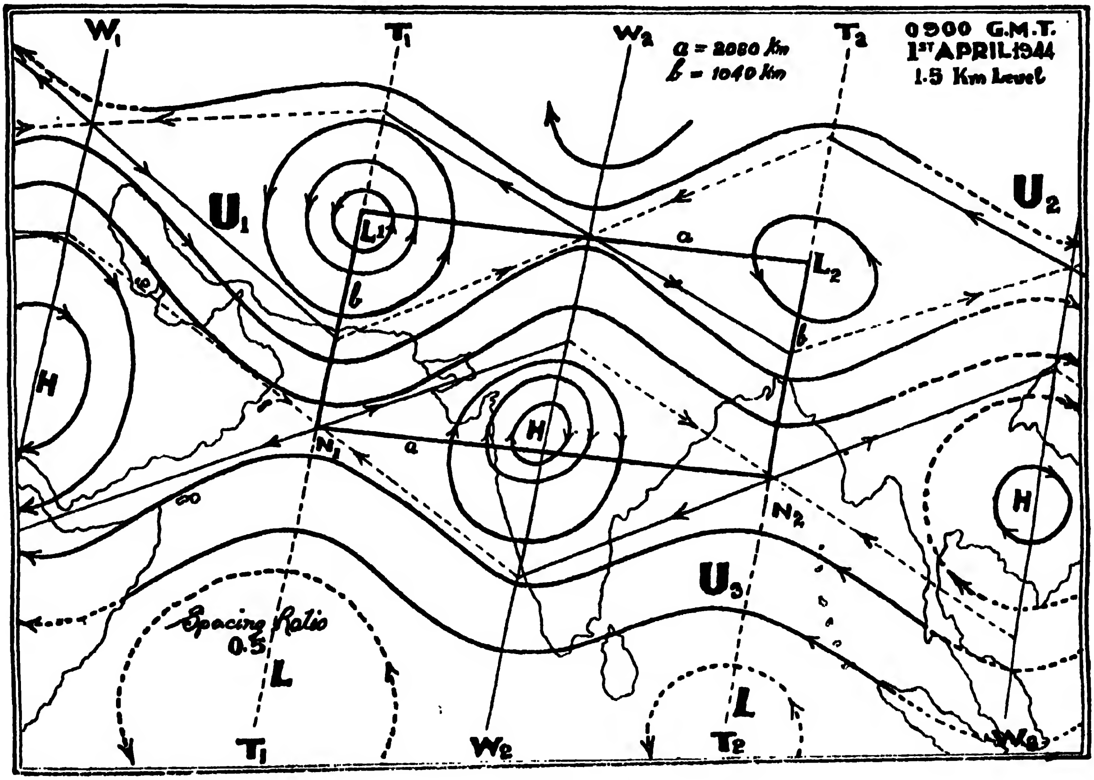

FIG. 1

From a study of the outstanding orographic relief of the globe, it is found that a grid of wedge lines, as shown in the annexed diagram may be extended right round the globe. An atmospheric street of one row of vortices may thus be built up from the more or less evenly spaced wedge lines WW. The trough lines joining the 'sinks' on the other hand, are blurred in this type of street. It has, therefore, no spacing ratio.

For the measurement of *b*, a line has to be drawn through the centres of the solid rotation cores of the negative vortices and another line through those of the positive vortices, as shown in the diagram. The average perpendicular distance between these two lines may be taken to be *b*.

The intercept, L_1L_2 or N_1N_2, between the trough lines, T_1T_1 and T_2T_2, is the wave length *a*, and L_1N_1 or L_2N_2 is *b*.

The centre of a solid rotation core may be called the 'no wind' or calm centre. The rule of fixing of 'no wind' centre, if there is one, of a cyclone for example, is based on the assumption of the establishment of an equiangular spiral (simple vortex *plus* translation) round a solid rotation core. The spiral is of diminishing radius in the case of a low pressure field or 'sink' ("spiral convergence") and of increasing radius ("spiral divergence") in the case of a high pressure field or 'source.' This rule, however, does not always lead to a satisfactory location of the calm centre for reasons explained in the following paragraphs.

The calm centre may be the centre of a cluster of forced vortices of the same sign, brought together by 'belting' or by translatory motion. By 'belting' is meant the fastening of solid rotations with closed streamlines of U_0, the neutral air. (U_0 is air without vorticity, in a uniform pressure field, inert because straight streamlines acquire solid rotation only, perhaps similar to the S-air of the Americans, losing vorticity while subsiding in a warm anticyclone). Incidentally, 'belting' brings distant air masses together. There can thus be 'cementing' or 'fusion' of adjacent solid rotation cores, when an undisturbed stream strengthens first and then weakens. These processes eventually produce 'col fields' or a conglomeration of forced vortices.

A diffusing A family echelon produces a single row of vortices or negative col fields. Similarly, a diffusing B family echelon produces positive col fields. These may be taken to be 'discs', more or less oval. Let there be an easterly street U_2 to the north of the westerly street U_1 and another easterly street U_3 to the south of U_1. With proper spacings of the positive and negative discs, an undisturbed stream U_1 strengthening again gives rise to a new street which, however, is necessarily complex and unstable. Thus the growth of a street from simple to complex is usually followed by subdivision of vortices. The life history of a coal field, therefore, is an important consideration in forecasting.

The significant facts gathered from the charts are (*a*) forced vortices of the same sign may diffuse into each other but never combine, (*b*) a cyclic field, which encloses forced vortices of opposite signs, is unstable. A coal field has an unstable structure, and a cleavage in the 'disc' initiates coal activity. Thus 'cleavage' follows 'belting'.

The determination of *b* is often difficult. For example, the evidence from the surface charts is that the 'discs' may have a number of so called 'no wind centres', appreciably separated from each other. The distribution of upper winds in a horizontal section of the generative shell, on the other hand, may not show more than two vortices of the same sign and only one of the opposite sign inside the Indian region. One of the two lines through the centres of vortices of the same sign, cannot therefore be drawn with confidence. In a case like this, the axis of symmetry of the streets has to be drawn before spacing ratio can be determined. With the axis tangential to the cores of the vortices, a determination of their diameter gives *b*. In the charts, however, either the 'sinuous wake' is broad or the cores are often displaced, owing to the development of a circulation round them, or on account of the presence of extraneous simple harmonic motions.

Despite all the imperfections and limitations explained in the preceding paragraphs, actual measurements from weather charts show that the spacing ratio of streets varies from 0·2 to 0·7. The winter cyclones often have a spacing ratio of about 0·3. A type of monsoon cyclones, which forms between a composite easterly street to the north and a composite westerly street to the south, has a spacing ratio of 0·5. This is equivalent to a spacing ratio of 0·3 in the case of a cyclone between two 'simple streets'. A complex street has also a spacing ratio of 0·5 and above. It is interesting to recall the stability criterion of the Kármán street in this connection.

In conclusion, it may be pointed out that a forecaster should ordinarily expect (*a*) an intensification of a depression into a cyclone, if the spacing ratios of the participating streets are likely to approach 0·3 in a contracting positive cyclic field, (*b*) a spacing ratio of 0·5 and above in a complex street is generally followed by col activity in both the negative and positive col fields, (*c*) ordinarily, a spacing ratio of 0·2 and less indicates a dissipating cyclic field and change of weather type, (*d*) col activity (which may be equivalent to anticyclolysis or cyclolysis) may give rise to dustdevils or tornadoes or simply to squall fields. In these phenomena, the direction of motion of air along *z* axis at the edge of a cyclic field is determined by abnormal thermodynamic and aerodynamic instabilities and may be directed upwards or downwards, according to the low or high pressure field locally set up, irrespective of the sign of rotation of the cyclic fields. The squall field will be discussed in another note.

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[1] This note is to be read along with the diagram on page 454 of Science and Culture, 9, 454, 1944.
[2] Unpublished Atlas of Normal Vortex Streets.

EXTENSION OF THE DIFFERENCE THEOREMS OF SINGER AND BOSE

(1) Singer[1] (1938), by using the properties of the finite projective 2 dimensional geometry PG $(2, m)$, has established the existence of a set of $(m+1)$ integers

$$d_0, d_1$$

such that the $m(m+1)$ differences $d_i - d_j$ $(i \neq j)$ reduced modulo (m^2+m+1) contain all integers 1, 2, ... $m(m+1)$ once and once only, whenever m is a prime or a prime power. The affine analogue of Singer's theorem is given by Bose[2] (1943) who has shown, by using the properties of the finite Euclidean geometry EG $(2, m)$, that given an integer $m = p^n$ (where p is a prime) it is possible to find m integers

$$d_0, d_1, \ldots \ldots . d_{m-1}$$

such that among the $m(m-1)$ differences $d_i - d_j$ $(i \neq j)$ reduced modulo (m^2-1) all integers less than (m^2-1) and not divisible by $(m+1)$ occur once and once only. These theorems enable us to represent PG $(2, m)$ and EG $(2, m)$ of a certain type compactly by difference sets which give the geometrical configurations by cyclic substitutions. Both the theorems are also useful in representing the incomplete balanced block designs of the *Design of Experiments*[3] (1943) as derivable from difference sets given by Bose[4] (1939).

(2) By using the properties of the t dimensional geometries PG (t, m) and EG (t, m), where m is a prime or prime power, the above theorems have been extended and their utility in the compact representation of PG (t, m) and EG (t, m) and the incomplete block designs derived from them have been studied.

(3) *Theorem 1.* Given an integer $m = p^n$, (p is a prime) it is possible to find $k = (m^t - 1)/(m-1)$ integers

$$d_0, d_1 \ldots \ldots d_{k-1}$$

such that the $k(k-1)$ differences $d_i - d_j$ $(i \neq j)$ reduced modulo $v = (m^{t-1} - 1)/(m-1)$ contain each of the integers less than v, $\lambda = (m^{t-1} - 1)/(m-1)$ times. The method of obtaining the difference set is as follows. If x is a primitive element of the Galios field GF (m^{t+1}) and if we do not distinguish between x^θ and ρx^θ where ρ is an element of GF (m), then there are v distinct powers of x, $x^0, x^1 \ldots . x^{v-1}$ in GF (m^{t+1}). The difference set is given by the distinct powers of the x's obtained from the expression $a_0 x^0 + a_1 x^1 + \ldots + a_{t-1} x^{t-1}$) by allowing the a's to assume all possible values of GF (m). For example, the difference sets in the cases, $t=3$, $m=2$ and $t=3$, $m=3$ are given by

0, 1, 2, 7, 9, 12, 13 (mod 15)

and

0, 1, 2, 5, 12, 18, 22, 24, 26, 27, 29, 32, 33 (mod 40)

Theorem 11. Given an integer $m = p^n$ (p is a prime) it is possible to find $k = m^{t-1}$ integers

$$d_0, d_1, \ldots \ldots . d_{k-1}$$

such that the differences $d_i - d_j$ $(i \neq j)$ reduced modulo $v = (m^t - 1)$ contain all integers less than v and not divisible by $w = (m^t - 1)/(m-1)$, $\lambda = m^{t-2}$ times each. The difference set, in this case, is obtained from the powers of x, the primitive element of GF (m^t) obtained from the expression $(a_0 + a_1 x + \ldots . + a_{t-1} x^{t-1})$ by allowing the a's to assume all possible values of GF (m) subject to the restriction $\Sigma a = 1$. The geometry EG (t, m) can be represented by the above difference set and the set of integers obtained from the powers of x given by the expression $(a_0 + a_1 x + a_2 + \ldots a_{t-2} x^{t-2})$ by allowing the a's to assume all possible values of GF (m) together with a symbol ∞ which remains invariant under any addition of the elements of the modul to it. These theorems also give the compact representation of the balanced incomplete block designs defined by v, k and λ given abotve. For example the corresponding sets in the cases $t=3$, $m=2$ and $t=3$, $m=3$ are given by

$$\left.\begin{array}{l} 0,\ 1,\ 2,\ 4 \\ \infty,\ 5,\ 6,\ 3 \end{array}\right\} \text{(mod 7)}$$

and

$$\left.\begin{array}{l} 0,\ 1,\ 2,\ 8,\ 11,\ 18,\ 20,\ 22,\ 23 \\ \infty,\ 0,\ 1,\ 3,\ 9,\ 13,\ 14,\ 16\ 22 \end{array}\right\} \text{(mod 26)}$$

(4) The theorems, given above, supply the results of Singer and Bose when $t=2$ and hence constitute suitable extensions. The detailed proofs of these theorems together with some examples will be given in a full paper to be published elsewhere.

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Statistical Laboratory,
Calcutta, 25-4-1944.

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[2] Bose, *Ind. Jour. of Math.*, 2, 15, 1943.
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[4] Bose, *Ann. of Eugen.*, 9, 353—399, 1939.

PREPARATION OF VIOFORM FROM 8-HYDROXY-QUINOLINE

VIOFORM (5-chloro-7-iodo-8-hydroxy-quinoline) is now used as a powerful antidysenteric remedy. 8-hydroxyquinoline is the starting material for the preparation of Chinosol and Yatren, both of which are useful antiseptics.

In order to obtain vioform directly from 8-hydroxyquinoline, the action of iodine trichloride on 8-hydroxyquinoline has been tried in different organic solvents (acetic acid, alcohol, chloroform, carbon tetrachloride) under various conditions. In each case, a mixture of vioform (m.p. 177-178°) and 5:7-di-iodo-8-hydroxyquinoline[1] (m.p. 200-201°) has been invariably obtained, and from this mixture vioform has been separated by treatment with chloroform in which it is much more soluble than the di-iodo compound, or by fractional crystallisations from acetic acid.

The formation of vioform in the above reaction suggested the introduction of chlorine and iodine atoms into 8-hydroxyquinoline in two stages, so as to yield vioform finally. But, the chlorination (by chlorine gas) or iodination (by iodine or iodine monochloride) of 8-hydroxyquinoline has yielded the corresponding 5:7-dichloro- (m.p. 178-179°) or 5:7-di-iodo-derivative.

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2-5-1944.

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HISTOPATHOLOGY OF BETEL VINE LEAVES ATTACKED BY A BACTERIUM

THE writer published a short note[1] on a bacterial disease of the cut betel vine leaves in storage. The work has been in progress since then and the histopathology has now been fully worked out. Though the betel vine is subject to a number of fungal and a few bacterial diseases, this disease of the betel vine leaves has not so far been reported from anywhere else. Ragunathan[2, 3] has described a bacterial disease of the betel vines in the field, which, however, is quite different from the present one.

This disease as was pointed out generally starts at the cut end of the petiole which affords a very suitable place for the entrance of the bacterium, though occasionally the disease may begin at any place on the lamina leading to the formation of localised brown or black spots. The progress of the disease is more or less similar in all cases. To begin with, water soaked area appears and this is followed by browning and later by blackening along the veins. In the earlier stages of the disease, the bacteria invade phloem tissues which being very rich in stored materials afford excellent source of nutrition to the parasite. Though the bacteria from the point of infection spread out in all directions, the progress, however, is most rapid along the phloem, with the result that sometimes in the course of a few hours, the phloem along a considerable length of the petiole, midrib and the veins, becomes completely destroyed. This can be seen by the naked eye since the dorsal part of the midrib and some of the veins in the earlier stage of the infection becomes soft and pulpy. The disease now advances from the phloem to the xylem vessels and through these or most probably directly, to the mesophyll cells. The phloem elements now become dead and disorganised and the xylem vessels are now packed with bacteria. In a number of preparations the bacteria were seen filling the xylem vessels and the cells of the mesophylls. This indicates that the spread of the disease to the xylem and mesophyll takes place more or less simultaneously. From the cells of the mesophyll the bacteria get into the intercellular spaces and finally the mesophyll cells are killed and disorganised.

The writer is indebted to Prof. H. Chaudhuri of the Punjab University for kindly going through the manuscript and making some useful suggestions.

College of Science,
Nagpur, 5-5-1944. R. L. NIRULA

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[2, 3] Ragunathan, C., *Ceylon Deptt. Agric. Leaflet* 39, 1926; *Ann. Roy. Botanic Garden*, Peradiniya, 1928.

A PRELIMINARY NOTE ON THE MICROFLORAL CORRELATIONS OF SATPUKHURIYA, GHUSICK AND ASSOCIATED SEAMS

IN recent years there has been a sharp controversy about the proper correlation of Satpukhuriya, Ghusick and some other associated seams of the Raniganj coal fields.[1, 2, 3] This portion of the field is variously disturbed by cross-faults, dykes etc. Hence, correct correlation from stratigraphical data has become difficult. So it is necessary to approach the problem from altogether a different point of view. The recent development of the study of microfossils in the correlation of coal seams in England and America has been found to be very helpful in the solution of the present anomaly.

A large number of samples from Ghusick, Kushadanga and Nega seams on the eastern side of

the Bonbishtopore-Mohshilla cross-fault, and upper Dhadka, Satpukhuriya and lower Dhadka seams on its other side were analysed following Raistrick and Simpson's method[4] modified. The spores and cuticles were artificially classified into several formed types and sub-types. Occurrence of each spore type is expressed in percentage and only the dominant types are represented graphically in a general spore diagram. Only one typical spore diagram from each seam is given in the correlation chart (fig. 1).

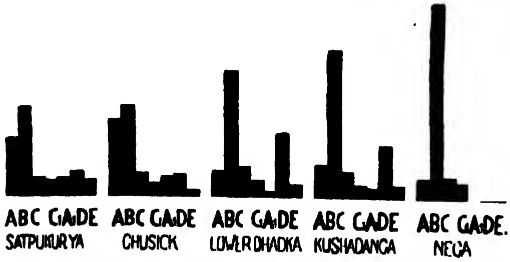

FIG. 1. Graphical representations of the spore contents of five coal seams in the Raniganj coalfield. A-E, the types of spore whose frequencies are represented by the heights of the black columns.

In a particular seam some general spore types (A, B and D) show a constant frequency of occurrence, which is, however, different from seam to seam. But the rest are present in more or less same proportion in all the seams examined. Hence, the latter group of spores may not be of much correlative value. Without entering into the details of correlation the author likes to point out that the spore diagrams of Ghusick and Kushadanga resemble those of Satpukhuriya and lower Dhadka respectively. Nega resembles none. There are, however, some points of difference between the spore diagrams of Ghusick and Satpukhuriya. The following correlations are provisionally suggested:—

(1) Ghusick and Satpukhuriya.

(2) Kushadanga and Lower Dhadka.

(3) Nega.

Studies on rare type spores (used as zone fossils) and cuticular structures tend to confirm the above correlations.

The details of correlation and points of palaeobotanical interest of the work together with descriptions and drawings of spores etc. will be published elsewhere later on.

My thanks are due to Mr N. N. Chatterjee, Geology Department, Calcutta University, Mr M. M. Mukherjee, General Manager, Martin & Co.'s Collieries and several other colliery officials, who have facilitated the work by helping me in obtaining the material, Mr A. K. Ghosh of the Botany Department, Calcutta University, for helpful criticism and advice and Prof. S. P. Agharkar, head of the Department of Botany, Calcutta University for giving laboratory facilities.

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Calcutta, 11-5-1944.

[1] Gee, E. R., *Mem. Geol. Sur. Ind.*, *61*, 256, 1932.
[2] Mukherjee, M. M., *Trans. Min. Geol. and Met. Inst., India*, *35*, part 3, 314, 1939.
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SYNTHESIS OF ATEBRIN

I find in an article entitled "Malaria—from the treatment point of view" by Dr K. V. Krishnan in the August number (1943) of the SCIENCE AND CULTURE that he refers to the synthesis of a substitute of Atebrin by Sir U. N. Brahmachari called "Acridine X". This reference is probably taken from Sir U. N. Brahmachari's Presidential address to the Medical Section of the Indian Science Congress at Calcutta in 1938. No paper seems, however, to have been published by Dr Brahmachari in subsequent years either on the synthesis of this substitute or its pharmacological and clinical tests. It may on the other hand be pointed out that quite a number of papers have been published on this subject by other authors in India[1, 2, 3, 4, 5] which have completely established the identity of the product and its therapeutic value. Several Indian firms, in fact, are manufacturing this product on the basis of this work and the limitation is only that of raw materials. It would have been desirable if Dr Krishnan had made some suitable reference to these detailed published papers and thus given credit where credit was due.

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Calcutta, 17-5-1944.

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[3] S. J. Das Gupta, *J. Ind. Chem. Soc.*, *20*, 1937, 1943.
[4] B. M. Das Gupta and L. B. Siddons, *Ind. Med. Gaz.*, *78*, 42, 141, 291, 1943.
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ESTIMATION OF CARBON IN COAL BY THE CHROMIC ACID REDUCTION METHOD

ESTIMATION of carbon in coal is carried out by the Standard Furnace Combustion Method but for the routine analytical work this method is a long and laborious one although the results obtained are accurate. It has been found that the Chromic Acid Reduction Method as modified by Allison[1] can be successfully extended to the estimation of carbon in coal for the routine analytical work. This method is a very rapid one and can be done within 20 minutes. When compared with Standard Furnace Combustion Method, the percentage recovery of carbon is 90·90% and by the use of a Factor 1·10 almost identical results may be obtained.

Briefly stated, the Chromic Acid Reduction Method consists in oxidising the organic carbon in a small sample of coal (passed through 100 mesh seive) with a known quantity of N Potassium Dichromate in conc. Sulphuric Acid by raising the temperature 175°C in 90 seconds. Then the extent of reduction is measured by titration with Ferrous Ammonium Sulphate using Diphenylamine as indicator.

The details of the paper will be published elsewhere.

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INDIA'S NEED FOR POWER-DEVELOPMENT*

THE modern age is fundamentally different from medieval times, and there are many ways of describing the difference. We sometimes say that we are in the age of steam or electricity. Another writer describes the modern age as 'neotechnic' (production in factories by industrialists with the aid of large machineries) as distinguished from 'paleotechnic' (production in cottages by artisans working with small tools). The third definition, though accurate, is pedantic. But probably nothing brings out the characteristic difference so vividly as the "Energy-Index"—by which term we mean *the output of energy or work per capita of the population per year from all sources.* Probably it will surprise some of our readers to learn that the energy-index† in medieval times was not more than 80, while in modern times it is nearly 2000 in a moderately advanced country and in the neighbourhood of 3000 in some of the go-ahead countries like U. S. A. or Canada.

What do these figures indicate? It shows that an average citizen of an advanced country, like Sweden, is today nearly 25 times richer than he was in medieval times, for wealth is directly proportional to the output of work. True, the total national wealth in most countries is not equitably distributed, but that is a different topic. If the country as a whole gets richer everybody shares in the benefit, though there is no denying the fact that an equitable distribution is far more beneficial and desirable. But the question at any rate is of secondary importance, for unless there be production there would be nothing to distribute. Countries, like Iran or China, which have till recently clung to medievalism, can never attain in spite of the traditions of a great past, or prevalence of saints or wise men, the prosperity, or material happiness of modern Sweden.

How has this profound revolution been brought about?

In medieval times, work was done almost entirely by manual labour aided by animal power (cattle and horse) and to a small extent by powers of nature (wind power or water power as used in water wheels first invented in Iran). In modern times work is done by power derived from coal (steam engines) and oil (oil engines) and by electricity generated from coal (thermal stations), oil (Diesel engine) or water power (hydro-electricity). For a country it is now possible to calculate, almost with mathematical precision, the whole amount of energy output from coal or oil consumed for this purpose, or from the records of electrical power companies. The total energy output divided by the population gives us the "Energy-Index."

Countries, like Sweden and Switzerland, which have very little coal and oil have to depend on electrical power generated almost entirely from water. In 1942, Sweden's output of work per capita per year was nearly 1700 units. In a country where steam power is very largely used, such as England, calculations are more difficult to carry out. In 1938,

* Based on a lecture delivered by Prof. M. N. Saha before the Calcutta Rotary Club on July 10, 1944.

† Note for the non-technical reader: The 'unit of energy' used here is the 'kilowatt-hour' *i.e.*, the work done by a machine having a power of one kilowatt for one hour. This is equal to one and one-third horse-power hour. The man-power hour is just one tenth of one horse-power hour *i.e.*, an average adult working for 8 hours produces only 6/10th of a unit (kilowatt-hour). The price of a kw. hr. charged by an electrical power company for industrial use is about an anna, so that a man working for 8 hours does work, whose normal value is 2½ pice. But generally man's work, even if it be entirely manual, is intelligent, hence the value is higher. For very unintelligent or mechanical work, like spinning or digging or drawing water the rating will be lower, say at twice the minimum.

the per capita electrical energy derived from coal was 650 in England. The per capita energy derived from steam and other sources has been calculated to be about 1400 units (this figure is given with a certain amount of reserve) so that the energy index for the U. K. amounted to about 2100 units. The figures for Canada and U. S. A. are higher, probably in the neighbourhood of 3000 units. The U. S. A. and Canada have enormous resources of water power and have developed a very large percentage of that, with the result that they are now ahead of the whole world in the production of work and in material prosperity.

Where do man power and animal power come in this picture? A man's output of work in the whole working year of 300 days is only $\cdot 6 \times 300 = 180$ units, and since we have to leave out old men, children, most of women and the idle rich for purposes of productive work, we can take the active worker as one in three. The average annual output by man power is therefore only 60. The output from animal power could not have been more than 20, so that in medieval times, the energy-index could not have been larger than 80. The output of work by man's physical exertions can now be entirely neglected in comparison to the energy output from other sources; his work is now mainly directive.

If we arrange the countries of the World according to the energy-index, at the bottom amongst the countries which claim to be civilized would be found India and China, and pre-Bolshevik Russia whose position in 1918 was no better than that of India in 1944. India's energy-index in 1944 cannot be much larger than 90 units even on the most liberal estimate; this is made up of 60 units derived from manual labour, 15 from animals, 9 from electricity in 1942, (the total production was 3500 million units) and about 10 units from steam and oil—the exact figures being not available. So the energy-index cannot be larger than 90 units, as against the Euro-American figure of 2000 or more.

The average annual income of an Indian was calculated by the National Planning Committee to be Rs. 65. The average income of a Swedish was about 1800 Kroners in 1938, or about Rs. 1300. He earns 20 times more than an Indian. The reason is quite clear; he uses about 20 times more energy. In fact we can assume that the average income of the citizen of any country from all sources would be directly proportional to the energy-index.

We can put the facts in more figurative language. In Europe and America forces of nature have been harnessed so effectively that an European or an American has literally 10—15 slaves working constantly for him. In India, the number is $1\cdot\frac{1}{2}$, one being himself and ½ derived from the harnessing of forces of nature and from animal power. We may say that in India the energy output is equivalent to $1\cdot\frac{1}{2}$ slaves, of which 1 is the man himself and ½ derived from other sources. This is probably just equal to half a donkey-power.

Utilization of Energy

How is the large amount of energy utilized in Europe and America? A substantial fraction is utilized in communication and transport which include rail and road travel, telegraphy, telephony, navigation, air travel, and radio and for domestic purposes; but the larger fraction is utilized in producing fertilizers, both phosphatic and nitrogenous, which have increased the productivity of the soil nearly four times; in extracting metals from ores producing alloys and chemicals, both heavy and fine, textiles, machinery, engineering goods, and miscellaneous consumers' goods and in the processing of forest products (wood and chemical pulp used for the manufacture of paper and rayon).

It is this large production with the help of natural power which has enabled men in advanced countries to attain a standard of living far beyond the dreams of medieval philosophers, a fact which is reflected by the rise in average longevity from 25 in about 1870 to over 55 in 1938 in Europe and America.* This is the result of better food, shelter and better conditions of public health rendered possible by greater wealth. Let us contrast conditions of public health in the two ages.

Public Health in Modern and Medieval Times Contrasted

It could be said that the child-bearing and child-burying were the chief occupations of women in the medieval age. Queen Anne of England lost all her fourteen children due to diseases which are now considered preventable; if any labourer's family at the present times has to suffer a fraction of the child mortality suffered by Queen Anne, probably the Ministry of Health would not last for two days. Conditions of public health, which are directly connected to income, are in India only slightly better than what it was in England in Queen Anne's time. We are told that there was no domestic running water in those days. Queen Elizabeth could afford only two baths in the month, and that was considered a luxury (Westaway: *The Endless Quest*). Probably, even the poorest man in England now takes at least 8 baths in the month.

* According to a report in *Science*, May 19, 1944, the longevity in the U. S. A. reached a peak of 64·82 years in 1942.

It is known to everybody that 90 per cent. of the people of India still lives in the sixteenth century,—a life of chronic malnutrition amounting in times to famine, disease and indescribable wretchedness. The amenities of modern life are available only to a small fraction of people living in the cities. Yet India has all the resources in power and materials which, if they were properly exploited, could raise her to the standard of the average European countries. The paradox is, as Dr Vera Anstey succinctly puts it, that the soil of India is extremely rich, but her people is extremely poor.

In the past, there has been much loose thinking regarding the methods by which the material condition of the average Indian can be improved, but it is only recently that there has been some objective thinking. The first step towards this was taken by the National Planning Committee of the Indian National Congress which sat during the years 1939 to 1941 at Bombay under the Chairmanship of Pt. Jawaharlal Nehru. It is pleasing to note that the Committee in its work secured ready and helpful cooperation from the Provincial Governments including those, like Bengal, which were not run by Congress Ministry. This shows the popularity of the idea of national planning. The Committee found that if the material condition of the average Indian were to be substantially raised within the next ten years, her production of energy should be raised by 40,000 million units per year (above the present figure). This may sound to be a very large figure, but a little reflection will show that the estimate is extremely modest. Even Mexico which is considered to be a rather backward country produces 180 units of electrical energy per capita per year contrasted to India's nine in spite of the chronic revolutions for which she had acquired a notoriety. The National Planning Committee's figure gives only 100 units per head, which is 1/20th of the per capita production in the U. S. A.

This energy can be generated by burning 20 million tons of coal, but India is markedly deficient in coal, and as an exhaustible national resource on which many essential needs of the nation depend it should be conserved for other purposes as far as practicable. It is desirable that most of this energy should come from electricity derived from hydro-electric sources* which exist in plenty. Further only a small part of India has coal; other parts, such as the Punjab, Bombay and the whole of South India, have to depend on longhaul coal. It is not only desirable, but almost imperative that the water power resources of these parts be properly developed. The hydro-electric survey commission should now be revived, if we really wish to pass out of the present axis combination of poverty, disease and malnutrition.

In the reforms of 1933, development of electrical power was made a 'Provincial Obligation'. The Government of India thus divested itself by one stroke of pen of one of the most important obligations of Central Governments of all countries, and the befuddled Provincial Governments mostly talked vociferously about industrialization which sometimes in their minds was identical with the manufacture of tooth-pastes and matchsticks without achieving anything, and with one or two exceptions did practically nothing useful.

We turn to a pleasant picture afforded by the progressive State of Mysore. Even before the first World War, the Mysore State, thanks to the farsightedness of Dewan Sheshadri Iyer, had harnessed the Cauvery falls at Shivasamudram, and after the World War, the work was further extended during the regime of Sir M. Visvesvaraya leading to an installed capacity of 48,000 kw., and production of nearly 300 million units of electrical energy. This gave the average of Mysorean nearly 50 units per capita. Encouraged by this success, the Mysore Government during the regime of Sir Mirza Ismail launched another great project calling for an expenditure of rupees seven crores for harnessing the waters of the Jog Fall in the Western Ghats. This is calculated to produce an installed capacity of 120,000 kilowatts, which is expected to yield nearly 720 million units, so that when these installations are in full working the production of electrical energy in the Mysore State would be nearly 200 per capita, or nearly double of the figure contemplated by us for the rest of India.

Amongst the provinces†, Bombay has shown the greatest amount of progress due to the enterprise of the Tatas who installed three power projects in the Western Ghats and thus ensured power-supply to

* India's hydel power resources were estimated or rather guessed by Mears in 1922 to be 20 million kilowatts, so that even on this estimate up to this time, barely 1 per cent. of the resources has been harnessed. But Mears' figure is most probably glaring underestimation, for he was asked to do things hurriedly and he had neither the time, nor the proper resource to make an accurate survey. A parallel is afforded by Soviet Russia which before 1918 was reported to have hydel power resources amounting to 20 million kilowatts; but accurate survey carried out by the Soviets showed that the figure was 280 million kilowatts or 14 times higher. Afer the last War the Government of India had a plan for largescale development of hydel power in India, but this was dropped in 1923.

† The development of electric power in India has taken place mainly through three different types of projects, namely (1) Government or State projects, such as the U. P. Ganges scheme, the Punjab Government's Mundi scheme, the Mysore Government's Shivasamudram and the Madras Government's Pykara schemes; (2) the schemes undertaken by the great joint-stock concerns, such as the Tata Hydro-electric scheme, the Andhra valley scheme etc.; and (3) small projects for thermal stations undertaken and operated by a host of private companies all over India.

the industries of Bombay. After Bombay comes Madras in importance, which province during the Congress regime has also made significant progress in the development of power through the initiation of such projects as the Pykara Scheme. The Punjab and the United Provinces had had some very unfortunate experience with their schemes of hydel development. But the experience, though sad, had at least some educative value, for the Punjab has become alive to the needs of power development and is reported to have embarked on some very ambitious projects planned by her *own engineers* in the Sutlej and other river valleys. These works, when completed, are expected to yield nearly 2000 million units. *Let us hope that the past mistakes would not be repeated.*

In India, we have many populous river valleys which are subject to violent floods and which, on account of thoughtless handling in the past, have gone down in prosperity and public health. The most glaring examples are the Damodar Valley in Bengal and the Mahanadi Valley which is practically the whole of Orissa. How these rivers can be turned into beneficial agencies is afforded by the example of the Tennessee Valley in the U. S. A. This area, comprising about 40,000 square miles was going down continuously, and in 1931, it was estimated that for a large part the income had dwindled to 100 dollars per capita in the year. In 1933, due to the personal initiative of President Roosevelt, the Tennessee Valley Authority (shortly called TVA) was created and within ten years the whole face of the country has been changed. The core of the whole work has been the construction of about 20 multipurpose dams built for flood prevention, irrigation and soil conservation, navigation and power generation. In 1943 according to the annual report of the Authority 9000 million units of electricity have been generated, (a summary of the report appears elsewhere in this issue), and about a stretch of 650 miles of the river had been rendered navigable. Agriculture and industry have been in a flourishing state. Jacks and Whyte put it:

> "Nature and vested interests turned a virgin country into a wilderness; but nature and man have again combined to make it a smiling garden".

It has been shown that the Damodar River Valley which is now notorious for its floods and malaria can be treated in the same way as the Tennessee and be turned into a beneficial agency yielding nearly 1,200 million units of hydel energy. Other valleys which can be treated in a similar way are the Mahanadi in Orissa, the Son and its tributaries in U. P., the Sutlej and other rivers in the Punjab, and the Koyna Valley in the Southern Bombay Presidency. In fact, if a plan of expansion is decided on, we do not see why India should not produce 200 units of electrical energy per capita within the next ten years.

We have tried to impress upon the reader the basic fact that the root cause of poverty of India is the hopelessly inadequate use of natural power. This is self-evident. Because, wealth can only be created by doing work. And, the work necessary for creating wealth of amount approaching that of the western countries cannot be done by man and animal power alone as is often held in this country. India must, therefore, develop and utilize to a vastly greater extent her natural power resources than she has been doing till now. Lenin, the Father of new Russia, realized the supreme necessity of developing power. One of his first acts on assumption of power was the appointment of a commission under Prof. Krzhizhanovsky to enquire into the power resources of the country. In fact, Russia began the development of power long before she launched her Five Year Plans. The Great Dnieper Dam was nearing completion when she started her First Five Year Plan in 1928. It is, therefore, imperative that the Central Government should at once set up a committee to make a thorough survey of the power resources of the country as a whole and establish suitable educational institutions to train a proper personnel. The survey is of basic importance and should be started immediately without waiting for the full formulation of the reconstruction plans.

The present global war has ruthlessly destroyed the normal tenor of life in every country by bringing ruin, desolation and disaster on an unprecedented scale. Out of these travails humanity is eagerly expecting the birth of a new age,—an age which will usher security and good living for the common man and good will and co-operation amongst the different nations. This has been the dream of founders of religions and of philosophers; but in the past ages all altruistic philosophy has been negatived by severe limitations on the powers of man to obtain sufficient material (food, clothing, shelter, and other essential necessities of life) out of Mother Earth, which will provide plenty for all. The result has been the robbing and the enslavement of the weak by the strong all over the world and in all ages, and the situation thus created still continues. But the scientific discoveries of the past and present centuries have so far increased man's power over Nature that production of all essential commodities can now be multiplied many times leaving a margin of plenty for all. Though the potentiality of development is apparent to the scientific man, those who rule are still obsessed by the lust for power, domination and exploitation of weaker peoples.

Would India enter on a period of planned development and prosperity, or would all the mistakes which were committed after the first World War be repeated?

ON MISGIVINGS ABOUT SCIENCE AND SCIENTIFIC RESEARCH IN INDIA

BHUPENDRA NATH MUKHOPADHYAYA

"WE do our best when we work under urgent stress"—the epigram, if true, would by implication put all of us on the level of the naughty child who refuses to work unless threatened by the "rod". Or, perhaps the epigram raises Newton's conception of "the external force" from the physical to the psychological world. That an external force is often necessary to break through our inertia is abundantly proven by the incidents of Narvik and Dunkirk. Whatever may be the psychological implications or philosophic background of such a contention, humanity marches forward through struggle.

The establishment of the Board of Scientific and Industrial Research in April, 1940 is only a reminder that India has entered within the threshold of a hard, long struggle. The Board has so far more than justified its existence and will no doubt continue, with other scientific and industrial research organizations, to render invaluable services to the community during the war period. But what concerns the thinking person of today most is the coming post-war period of still harder struggle, especially for us in India. It is easy to grasp the war-aim ; even the politicians of the world have grasped it : they say that their war-aim is to beat the enemy. I do not think anybody would seriously doubt their sincerity—it would be rather strange if people should fight with a view to let their enemy win! What the politicians cannot grasp or cannot agree upon is the peace-aim. It is difficult to grasp not only because it is fundamental (fundamental things are often the most difficult things to grasp), but because it is not yet the same for all peoples. For the people of India the problem is straightforward enough. Our principle has always been "to live and let live" and there cannot be any deviation from this golden rule. Our first and foremost duty is therefore to feed, clothe, and house our people ; and the scientists must do their utmost to secure these essentials. Some of our younger generation—the progressive thinkers—may be thinking in terms of internationalism ; but it must at all cost be realized that national weakness does not contribute to international strength. The stupendous energy of the U. S. S. R., which held the avalanche of blitzkrieg, is but the galvanized strength of the highly developed individual autonomous States.

"The aim of every post-war reconstruction in India", said Sir J. C. Ghosh in his opening address on the occasion of the Symposium on Post-war Organization of Scientific Research in India, "should be the removal of these two weaknesses. . . . . 'A low national income and limited industrial development'. And we are met together today to discuss how science should be organized in India so that this object may be achieved." This is a clear statement of the aim of the scientists in post-war India ; and there is no cogent reason—moral, ethical, economic or political—why science should not be pushed forward to achieve this end. There, however, seems to be, as pointed out by Sir Jnan at least two schools of thought in the country who view any prospect of scientific and industrial research with apprehension. Sir Jnan would have been more effective in putting forward the case for the scientists had he, instead of trying to persuade his opponents into his belief, pointed out the fallacies of their process of thinking. Firstly, there are those who do not favour scientific research or industrialization in India because of their disgust of the accompanying evils they have witnessed in the West ; and secondly, those who favour industrial development but consider scientific research for this purpose to be unnecessary: they think that by importing foreign machinery and experts we can develop our industries ; "they are in favour of providing such technical education in the country which will enable the industry to be run by indigenous talent after a period of probation under foreign experts."

I should like to deal with the second opposing thought first ; as the consideration of the first would involve graver and more fundamental issues.

Those of us who believe that we can profitably employ and utilize the results of foreign research in our industry are not only thinking in terms of parasitic existence but also in terms of permanent economic dependence and political servitude. The chief error of this type of thinking lies in the failure to realize two basic facts of our modern world. In the first place, we are living in a highly dynamic world where everything is changing, and changing fast ; the ancient sword has given place to the modern gun ; the modern Hurricane is now making room for the ultra-modern jet-propelled aircraft ; and the time-honoured peaceful occupation of growing paddy and potato in the field is now a "home front"! Yesterday is being outdated by today, and today by tomorrow, at a speed unknown in human history. Secondly, side by side with this tremendous change is the tendency of our world to get progressively smaller in the sense that its inhabitants are being

brought closer together. So, what one does now in one corner of the world is bound to have repercussions in all four corners. When science has abolished natural barriers between people and people, and country and country, what chance is there for our artificial barriers to survive? We must adapt ourselves to the changing circumstances of the day in the light of facts or else perish. If we, therefore, dispense with research and depend on others for our industrial development we shall not only live under conditions that were good only in the out-dated past, but advances made elsewhere are bound directly to affect our industries with adverse consequences. We shall keep on importing foreign machinery and foreign experts *ad infinitum* only to find ourselves permanently settled in the degenerating past.

On the other hand, the opinion of those of us who, to quote Sir J. C. Ghosh again, "have been so impressed by the evils of the modern world, that they do not hesitate to declare that the introduction of Western methods for increasing our national income should be resisted," is based on more fundamental ground. They have seen the Western civilization crumble under its own power of science and industry; they have seen how women and children are being slaughtered with lightning speed by the monstrous technique of science: to them the abstract concept of "science" takes the concrete forms of bombs and torpedoes, tanks and guns, mines and mortars—instruments of misery and destruction. It is but natural that they should forget all the good that science has done and is still doing to humanity—Penicillin, Patulin and M. & B. are a poor match for the High Explosives. Human mind does not measure good and evil by balancing one against the other and ticking them off, but by the quality of impression that is left behind: and impressions of fear and horror outlast pleasurable impressions both in intensity and in time.

How, then, are we going to answer those who maintain that science is responsible for the two major catastrophies in Europe, and that it would bring only disaster to India? Sir J. C. Ghosh's suggestion that these people should be educated out of their conservatism, and that the men of science in India should preach that science is capable of doing immense good to humanity and that the evil results are due only to evil men, does not appear to me to be adequate. For, in the first place, the distrust for science on the part of a large section of our public is not due entirely to conservatism; and secondly, preaching the virtues of science without convincing argument would merely betray intellectual lethargy on the part of our men of science and would ultimately defeat its own purpose. The case for science is strong enough to allow itself to be established by the dispassionate array of facts and logical arguments, without appealing to human emotion and sentiment.

The outstanding feature of the Western civilization of today is, as it appears to me, not the enormous scientific and industrial power, but the colossal gap between this power and the power of man to control and direct it for the benefit of mankind. Science is progressing every day, but man has so far been unable to keep pace and adapt himself to the new environment. In other words, human wisdom is sadly lagging behind scientific knowledge. The advancement of science in all its branches has given man an immense opportunity to improve his physical existence, so that he may be better able to progress along the path of higher values; but he, being blinded by the chimerical brilliance of his own material achievement, has shifted the emphasis from the moral to the material aspect of things and in the process has completely lost his aim. Lin Yutang, the noted Chinese writer, has, at a recent interview with a representative of a London newspaper, said ". . . . but I think when the West talks of culture it often means civilization. Bath-tubs, wireless, telephones are civilization. Culture is another thing. It lies, for instance, in the manners, the attitude to life of the Chinese peasant—kindness and tolerance and the ability to live side by side."

Another feature—a very significant feature especially in the light of modern psychological researches—of the present day Europe, is the lack of serious faith. Even Newton had his God; but the man-in-the-street today is largely impelled by the motives of day to day affairs. Science has usurped the place of God in the ordinary man's heart but has not been able to give anything in its place. The light of scientific knowledge has, it is true, dispelled the darkness of ignorance and superstition; but the need for faith is a human need and must find its expression elsewhere. This explains the authority of the Führer and the belief in blood and soil in Germany. The initial triumph of the Fascist forces is in no small measure due to this implicit faith upon their respective lords. But the authority of a man is bound one day to be questioned—that of God is unquestionable and hence permanent. The gallantry of the Soviet peoples who draw their inspiration from their faith in their Fatherland and the ideals it stands for, illustrates the dimension of the human power, which with the help of science could successfully withstand the greatest pressure the human race has yet been called upon to bear. The recent steps that are being taken towards decentralization within the U. S. S. R. show how strong are their love and faith for their local territory—the Fatherland.

It may be argued that if the human mind has been unable to adapt itself to the changing environ-

ment introduced by science in the West, what is the guarantee that it would be different in the East? Taking human nature as it is, is it not better that science with its potential danger be kept out of its reach? The answer to this is fairly simple: We do not stop using fire because its misuse or abuse may burn us. The best course is to train ourselves to use it in the proper way. Moreover, science has come to stay; and if we do not care for it in India we would, it is true, have to go without its benefit; but we are sure to share its evil effects through its misuse by others—we are sharing it now. As regards faith, we have enough—if not too much—in India now; any advancement of science in our country would in effect help to re-establish and strengthen the genuine faith by disentangling it from the myriad adventitious beliefs based on ignorant superstitions.

In conclusion I may emphasize that the real cause of the disastrous result of the present European civilization is not so much the introduction of scientific knowledge as the failure to introduce structural changes in the society to meet the new social functions which this knowledge has imposed. The industrial revolution brought about a sudden and violent change in the function of the society; but the social structure was allowed to remain practically medieval in character: the feudal lords handed over their power and position to the shrewd businessmen with capital, and the labourer left the land and came to serve his new master in the factory. Not only were the business magnates able to take complete control of the nation's wealth and productive power, they were, with the help of the new tools which science had placed in their hands, better able than the noblemen to exploit the resources of the nation to their sectional interest. This concentration of power and wealth in the hands of the few is the ultimate source of the present-day trouble. It is, therefore, not surprising that the peoples of the Soviet Union should be able to strike a better balance between the structure and function of the social body with their much altered social condition.

The present unfortunate results of the European experiment with science need not, therefore, frighten us; for, not only we ought to learn our lesson from this experiment, but if we pin our faith to our vastly different tradition, where the realm of facts has always been subordinated to the realm of values, we shall not fail to combine scientific knowledge with human virtues. If Pasteur were alive today, he would, instead of saying "Science is the soul of all progress and the source of all prosperity", have said "Science is the soul of progress of all and the source of prosperity for all."

LOUIS PASTEUR AND HIS WORK

JUGAL BEHARI LAL,
LATE DIRECTOR OF PUBLIC INSTRUCTIONS, BHARATPUR STATE

[This One Act Play was written by Mr Jugal Behari Lal, M.A., Late Director of Public Instructions, Bharatpur State, to be staged by the pupils of the State College. Several plays and dialogues have been written by the author; and science, health and diet campaigns were conducted in the State and the neighbouring provinces.]
Ed.—*Science & Culture.*

SCENE I.

A STREET IN PARIS. *Enter Chappuis, Pasteur's friend and Biot, a famous scientist and admirer of Pasteur.*

Biot. Well met Chappuis, I was coming to you. You alone have influence over Pasteur and can shift him to Arbois from Paris which is being evacuated. If we save Pasteur, we save France and the world; there is that promise in the youth. An old chemist like me, after thirty years' effort, could not produce pure racemic from tartaric acid, which he has effected. From vision to vision, this prodigy further detects the ferments, when experimenting on the tartaric acid. Pasteur's quest for the racemic acid takes him from the illusory boundary that separates life processes from purely inorganic reactions. Grappling with the manufacture of alcohol from beet sugar, he discovers the tartaric acid fermentations, which fixes the date of "New Learning".

Chappuis. Who could be more proud than I his bosom friend, when he defeated the Liebig group of molecular physicists after 20 years of struggle? He could hardly ever be induced to leave his laboratory even for a walk when performing one experiment after another to confirm that fermentation, decomposition and putrefication all "are acts of life", and in the absence of life do not take place. Germs also have parents.

Biot. This has led him to discover that the various infectious diseases are originated by germs.

Chappuis. He has discovered both the diseases of the silk-worms and their cure and proved that they are contagious and hereditary. France has gained millions and millions. During these four years he lost father and three of his daughters—Camille, Cecil and Jeanne. The tenderest heart in the world is carried by the world's greatest living scientist—Pasteur. The microscope almost blinded him when he looked for the invisible typhoid germs which had carried off his three babies and made his home desolate.

Sounds of shells bursting.

Biot. Here are the Germans shelling our Paris. Run, run and save Pasteur and his laboratory. [*Both run away*].

SCENE II.

PASTEUR'S LABORATORY. *Pasteur and his two laboratory assistants working on a table full of apparatus, chemicals and cultures.*

Pasteur. Life in the midst of danger is *the* life, the real life, the life of sacrifice, of example and of fruitfulness. Both the silk-worm diseases—Pebrine and Flachery, are conquered, and the Chicken-Cholera germs have got cultured by chance.

1st Asst. In the field of observation, Master, chance only favours the mind which is prepared.

Enter Biot and Chappuis, running and breathless.

Chappuis. Pasteur, pack up, run. Metz, the strongest fort of the world has surrendered without a struggle to General Moltke and this great Paris is surrounded. Evacuation is ordered. There is still a way out of Paris. A moment after, it would be too late. A shell at any moment may smash you and your laboratory to atoms.

Pasteur. I leave my Paris at this crisis? My father was a soldier before he was a tanner. He fought in the battle-fields of Europe in the valiant Third Regiment—the brave among the brave, and earned the cross of the Legion of Honour. I will die before I leave Paris.

Biot. Can you fight? You will be the worst soldier of France. But you can discover things to defeat Germany. Why not do what you are capable of, if your patriotism is genuine?

Pasteur. My beloved France is defeated, dishonoured and humiliated. We must end and let things go their own way.

Biot. It is not for a hero of Science like you to lose heart. Live and win by your Science. As a force you count for nothing, as a wisdom you are the highest in the world. Fight with your own weapons and not with those of the enemies'.

Chappuis. You have no right to stay; you would be a useless mouth in the siege.

Pasteur. It is a cruel-kind argument and I yield to you. I would raise my beloved France above Germany by improving the wines, vinegar and the brewing of France. I would save my wounded countrymen by the Listerian antiseptic dressing and sterilizing wounds. For the memory of my diseased children and for the honour of France, I would give the heart its share in the progress of science.

Bursting of shells increasing.

Chappuis. Run, run. [*All run away with the laboratory tables*].

SCENE III.

Bombardment of Paris.

SCENE IV.

Enter Pasteur and his two assistants.

Pasteur. Blessed is he who carries within himself a God, an ideal and who obeys it: ideal of art, ideal of science and the ideal of the gospel of virtues. Therein lie the springs of great thoughts and great actions; they all reflect light from the Infinite. Let us do our bit. Five per cent of the cattle and ten per cent of the sheep in France die of anthrax. Davaine and Koch have isolated the bacilli but could not effect the cure. I have taken up the problem. I had taken 50 sheep and 25 were inoculated with the anti-anthrax serum, while the other 25 were not so inoculated. I have since infected all with the virulent disease. If the inoculated ones survive, the principle of inoculation will be established. In the case of Chicken-Cholera culture I have found that it loses strength merely by keeping, and a fowl inoculated with this weak culture suffered only a passing indisposition and afterwards was immune from the attack of this virulent disease itself. The principle of inoculation should apply to anthrax and all the infectious and germinal diseases.

Noise without.

1st Asst. Master, there is a crowd of farmers who wish to see you.

Pasteur. Let them come in.

Enter Farmers.

Farmers. Saved, saved, our cattle are saved. Hail Pasteur! Long live Pasteur!

2nd Asst. Quiet, quiet. There is an old woman with two children, wailing and crying and wishing to see you.

Pasteur. Now friends, leave me. I have to attend to other business. [*The farmers leave, saying "Long live Pasteur. Pasteur for ever."*]

Pasteur. Jenner, Jenner, you have discovered the vaccination against small-pox. How can the world ever forget you? Working so far apart we are guided by the same human spirit. I have discovered the anti-rabic serum. But what can this woman and the children want?

Enter an old woman and two children.

Mother. Monsieur Pasteur, my children Meister and Jupille are bitten by a mad dog. Nothing, except you, on earth can save them from the suffocating mad struggles of hydrophobia and the most painful death. O! save them, save them. [*Cries bitterly, while the children cling to him and cry. Pasteur also cries out of sympathy.*]

Pasteur. Lady, I have succeeded in curing mad dogs but I have not yet tried the inoculation on human beings. I cannot bear to see the reaction and the possible pain resulting in death and cannot apply the treatment without being sure of the result.

Mother. O! Try this desperate remedy.

Pasteur. I cannot unless Vulpian can assure me of its success.

Mother. We will call Vulpian here. [*Mother and the children depart.*]

Pasteur. The anthrax bacilli are isolated by Davaine and Koch but I have not been able to detect or isolate the raby germs, yet the disease is of germinal origin, as the inoculation has proved. Is it a virus like the small-pox germs, too small to be detected by a microscope? I have submitted my anti-rabic treatment to the Government who have appointed a Rabies' Commission under Vulpian. Vulpian will tell the result if he comes. I rely on Vulpian, the greatest physician of the age.

Enter Vulpian.

Vulpian. Good morning, Monsieur Pasteur.

Pasteur. The same to you.

Vulpian. The year 1885 will be memorable in the history of the world. Your anti-rabic treatment and inoculation have been proved and confirmed by the Commission. The Government have ordered Pasteur Institutes to be opened throughout France to perpetuate your great memory. A time will come when every big centre in the world will have a Pasteur Institute. I have treated the two children strictly according to your method and they are cured. You are a benefactor of mankind, you have solved the problem of "Man or the Microbe" in favour of mankind!

Enter the mother and the two children cured. They jump and kiss Pasteur.

Pasteur. Hallo my children you are cured. In you I see my Camille, Cecil and Jeanne resurrected. It is one touch of Nature that makes the whole world kin. Live France, live all mankind and prosper!

All. Hail Pasteur! Immortal Pasteur!. [*Lift up hands.*]

DROP

A. FUEL RESEARCH PROGRAMME FOR INDIA

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A FUEL Research Institute is to be established by the Government of India. This is the time to discuss as to what would be the best programme for such an institute. Any such national institute should obviously have two fundamental issues to deal with; firstly, the maximum economic utilization of the nation's fuel resources and secondly, the production of substitutes for those natural fuels that are not available in the country. From both these points of view, India can be compared with Britain, which country had established a fuel research institute as early as 1917, to find out ways and means for optimum economic utilization of British coals which have been showing a steady rise in price since long, and also to develop methods for the production of liquid fuels —substitutes of petroleum products—for internal combustion engines. It is thus interesting to know how the British Fuel Research Board proceeded to formulate their programme. The following is an extract from the first report (1917) of the Board of Fuel Research* to the Lord President, Privy Council for Scientific and Industrial Research.

"The field to be covered by Fuel Research is admittedly a very wide one. It embraces inquiries into the sources and qualities of coals, oil shales, natural oil and gas, and peat; into the methods of preparation of manufactured fuels from these natural raw materials and into the methods of consumption of the various forms of natural and manufactured forms of fuel for the production of light, heat and power. The underlying motives in these inquiries must be the securing of greater health, comfort and convenience for the community, combined with the more economical use and development of the natural resources of this country.

"It is proposed that two main lines of inquiry should be followed, but should opportunities present themselves for the effective pursuit of other lines, they have to be able to utilize them.

"The first of these lines of inquiry originated in proposals from the Coal Conservation Sub-committee of the Reconstruction Committee for a complete Survey of the Coal Resources of Great Britain. The part of this inquiry with which the Board is more immediately concerned is the examination and classification of the coal seams of the various coal mining districts by means of chemical and physical examination in the laboratory. At the discussion, which have taken place at the Coal Conservation Sub-Committee it has emerged, that the inquiry is intended to cover two aspects of the subject, the immediately practical, and the theoretical and more remotely practical.

"On the immediately practical side, it is proposed to take stock of the coal resources of each district, as these are already known to exist, to classify according to their qualities the seams which are being worked or which might, under certain circumstances, be worked and to ascertain broadly the industrial uses to which the different kinds of coal are being put. The classification for practical purposes involves the formulation of standard methods of sampling and testing. The testing would be done primarily in the laboratory and would be so carried out that standard values related to the purposes for which each kind of coal would be most suitable might be assigned to the various seams, *e.g.*, for carbonisation for metallurgical purposes or for illuminating gas making, for steam raising in land or marine boilers, for the production of heating or power gas or for domestic use. The formulation of a complete testing scheme and the establishment of standard methods of testing will need to be carefully discussed by laboratory and manufacturing experts.

"On the more theoretical side of the inquiry investigations will be required as to the nature and origin of the various types of coal and into the chemical and physical behaviours of their constituents under the action of heat and other agents. These investigations would be systematized and followed up energetically and *every reasonable resources should be put at the disposal of the scientific workers who are prepared to take up the work.* (Italics are ours). By concentrating scientific investigations in the first instance on those coals which are widely known and used in industry the work on this side of the enquiry would be most readily kept in touch with that on the more immediately practical side, and the new knowledge acquired by the scientific worker would at once be available for the use of his practical colleagues.

"The second of the proposed lines of enquiry has been led up to by a variety of influences. Amongst these influences have been the demands for cheaper and more ample supplies of electrical energy, for home supplies of fuel oil for the navy and of motor spirit for the transport and air services, and last, though by no means least, a definite demand for a smokeless domestic fuel brought about mainly by the growth of public and municipal opinion as to the great evils due to atmospheric pollution caused by the smoke and corrosive gases emitted by industrial and domestic fires. The only development which would satisfy these needs simultaneously, is the replacement of a large proportion of the raw coal which is at present burned in boilers, furnaces and domestic fires by manufactured fuels prepared from raw coal by submitting it to the distillation.

"These problems can only be solved by carefully organized experiments on a working scale carried out under the conditions likely to arise in practice."

The above extract gives a precise idea of the fundamental considerations involved in the formulation of the research programme that was to be followed by His Majesty's Fuel Research Board. The actual programme, which was subsequently decided upon and which was followed for the first decade,

* The members of the Board were Sir George Beilby, F.R.S., Hon'ble Sir Charles Parsons, K.C.B., F.R.S., Sir Richard Redmayne, K.C.B., and Sir Richard Threlfall, F.R.S.

by the British Fuel Research Institute, was as follows:—

"(1) The organisation and development of the Physical and Chemical Survey of the National Coal Resources with a view to ascertaining the most suitable method of utilizing the various seams and in particular their suitability for treatment by carbonization or otherwise.

(2) The obtaining of data of unquestionable accuracy for the preparation of thermal balance sheets for various methods of coal carbonization and the gasification of coal and in connection with the use of gaseous fuels in industrial furnaces.

(3) The obtaining of data for the preparation of economic balance sheets for carbonization, gasification and furnacing operations.

(4) The obtaining of similar thermal and economic data in connection with the use of peat as fuel.

(5) Experimental work on carbonization at temperature up to 650°C and on various types of apparatus for this purpose.

(6) The study of the coke produced under (5) from various types of coal as a smokeless fuel for domestic and industrial purposes, either directly or in the form of briquettes.

(7) The study of the oils produced under (5) as a source of fuel oil for use by the Navy in steam boilers or in Diesel engines.

(8) The study of the gases produced under (5) with a view to their utilization directly as a high grade fuel or as a source of fuel alcohol.

(9) Experiments in the carbonization of coal at high temperature to ascertain the influence of temperature, rate of heating and other variables on the quality of coke and gas produced, and other yield of by-products.

(10) The use of pulverized fuels in operations of various kinds.

(11) Steam-boiler tests of various fuels including the products of the carbonization of coal.

(12) The production of oil from natural fuels by processes other than that of carbonization.

(13) The production of light oil from heavy fractions or residues.

(14) The use of various types of liquid and gaseous fuels in internal combustion engines.

(15) Investigation into the production of light spirits other than those produced from natural oils, coals, etc.

(16) Investigation of instruments and devices suggested as aids to economy in fuel.

(17) Investigation into the use of fuels for domestic purposes and similar applications.

(18) General investigation into the chemistry of fuels and the processes for fuel applications."

It is clear that whatever other items might be included in the research programme for India, the above investigations will also have to be carried out here, as they are equally significant for all country's rational fuel utilization. A good part of the above programme involves work in Low Temperature Carbonization. This is to be explained, perhaps, not only by Britain's urgent necessity for production of petroleum-product substitutes, but also because of high hopes entertained during the decade 1914-1924, on the possibility of production of liquid fuel from coal by Low Temperature Carbonization. With the development of the processes of Hydrogenation of coal and Fischer-Tropsch synthesis, however, there is a growing opinion that work on Low Temperature Carbonization is futile. It has to be submitted however that both the latter processes involve intricate chemical engineering operations, especially in the realm of high pressure technology. The cost of petrol obtained by the two processes is also very high. Low Temperature Carbonization has a further significance for India, as the vast reserves of Indian coal are mostly non-caking and can thus hardly be profitably processed by High Temperature Carbonization. One great offset in Low Temperature Carbonization has been the disposal of the heavier fraction of tar which is obtained in much greater yield. It has been reported,[1] however, that a process has been developed by His Majesty's Government in Britain to utilize this tar for road construction. If this works successfully, India will need primary tar for her innumerable roads still to be constructed. The last word on Low Temperature Carbonization, it appears, has not yet been said and for obvious technological, chemical and economic reasons, it can hardly be advised not to follow up Low Temperature Carbonization. One word more need be said as regards this process. Unsaturated gases constitute today the raw materials for the production of innumerable basic synthetic organic chemicals. Whilst America obtains the supply of these gases from the petroleum industries, others will have to develop processes for their production from coal. Britain has already established a Gas Research Institute, with Dr J. C. King, as its first Director.[2] Here, it seems, investigations will have to be made on the possibility of production of olefines from Low Temperature Gas.

Certain inherent peculiarities of Indian coals demand research in some other directions also. For Indian coals are sadly characterized by a higher content of ash, which is again believed to be intrinsically bound with the main mass of coal. Secondly, there are coals with high percentages of moisture and sulphur. Russia has done wonderful works towards the utilization of this type of coals and some of Russia's super-pressure steam boilers are running with coals of very high contents of moisture, sulphur and ash.[3] Surely we can also use our inferior coals and it will be the responsibility of the future Fuel Research Institute to develop processes for the purpose. The non-caking nature of the majority of coals necessitates urgent and energetic work on the items 6 and 10 of the above programme.

[1] *Chemical Age*, Annual Number, 1942.
[2] *Chemical Age*, Annual Number, 1942.
[3] *Soviet Science*, J. Crowther, Kegan Paul, London, 1936.

As regards liquid fuels for internal combustion engines, India is decidedly at an advantageous position, as compared to Britain. Petroleum and even coal may get exhausted. But vegetation is perennial. We must use alcohol and wood charcoal in spontaneous ignition engines and vegetable oils, like groundnut oil, in compression ignition engines. All modifications necessary in engines for using these substitute fuels should be investigated and standardized. This deserves, in our opinion, the immediate attention of the Fuel Research Institute to be established.

In view of the above considerations, it appears, the programme for India should include the following items as well, in addition to the eighteen detailed above.

(1) Investigations on the methods of washing and cleaning Indian coals.

(2) Investigations on the processes for production of olefinic gases from Low Temperature Carbonization gas to produce the basic materials for production of synthetic organic chemicals.

(3) Investigations on alcohol-burning engines.

(4) Investigations on the use of vegetable oils in Diesel Engines.

(5) Investigations on producer-gas engines and charcoal for use in these engines.

PRIMITIVE PRODUCTION IN NORTH EAST AND CENTRAL INDIA*

NARENDU DATTA MAJUMDER

THIS paper is an attempt to study the productive activities of the Mongoloid Indo-Chinese tribes of Assam, *e.g.*, the Khasi, Garo, Naga and Lushai Kuki etc., and the Pre-Dravidian tribes of Santal Parganas, Chota Nagpur, Central Provinces, and the Eastern Ghats between the Godavari and the Mahanadi, *e.g.*, the Santal, Munda, Gond, Kond etc. The problems discussed here include (*i*) the different ways of exploiting natural resources to satisfy needs, (*ii*) the relative importance of the different types of production, (*iii*) the relation between the physical environment and production, (*iv*) the principles of the division of labour, (*v*) co-operative labour, (*vi*) slave labour, (*vii*) the organization of production, and others.

The conditions of material life exercise an enormous influence on the spiritual or ideological life of society. These conditions of material life of society include geographical environment, growth and density of population, and economy. It is true that each one of this complex of conditions influences the development of society, but the degree of influence is not the same in every case. Of all such conditions it is the economy that has the greatest influence on social development. Of the various factors that go to make up the economy of society—production, exchange, distribution, and consumption—it is the method of procuring the means of livelihood, the mode of production of such material values as food, clothing, houses, fuel, foot-wear, instruments of production etc., that constitutes the chief force in determining the physiognomy of society, the character of the social system, the development of society from one system to another.

The importance of production in the development of society was recognised as early as the 4th century B.C. when Dichaerchus spoke about the three stages of hunting, pasturing and agriculture in attempting to discover the principal land-marks in social development. I am not here trying to prove the validity or otherwise of the classical theory of the three stages, but my sole object is to show that the exponents of the classical theory, at least, realised the determining part played by production in the course of human development. Whether or not it is possible to discover all the stages through which mankind has passed, and if so, what these stages are, is another question.

According to the school of historical materialism, founded by Karl Marx and Frederick Engels, the mode of production may be analysed into two aspects: (1) the productive forces, and (2) men's relations of production, or economics relations. The first aspect expresses the relation of men to the objects and forces of nature which they make use of for the production of material values, while the second is the relation of men to each other in the process of production.

The productive forces are, again, divided into three elements: (1) the instruments of production

* Read at a meeting of the Anthropological Society, University of Calcutta.

with which material values are produced, (2) the people who operate these instruments and carry on production, and (3) production experience and labour skill.

The above-mentioned school holds that the noble of production is a mobile and changeable factor, and that any change in the mode of production is bound to lead to changes in the whole social system, social ideas, political views and political institutions. They further maintain that of the two aspects of the mode of production the productive forces are more mobile, and that of the three elements of the productive forces the instruments of production are the most mobile. So, changes and development of the instruments of production are bound to initiate a whole series of changes and development -first of the productive forces, then of men's relations of production, and finally of the physiognomy of society, of the whole social system.

It is regrettable that very little has been done by anthropologists to study the role and significance of the mode of production in social development, the effects of changes in the mode of production on the physiognomy of society. I am, mentioning this here in the hope that future investigators will tackle this problem.

The various ways in which the primitive tribes of India exploit their natural resources to satisfy their needs, in other words, the different types of economic activities prevailing among them, are: (1) collection of edible fruits, roots, plants etc. from the forests, (2) hunting, (3) fishing, (4) domestication of animals, (5) cultivation, and (6) arts and crafts. Though the relative importance of the different forms of production vary in different tribes, all of them agree in having cultivation as the most important form of production. The production of food is the chief preoccupation of all these tribes.

The collection of forest products has always been of great importance to these tribes as a subsidiary source of food. In seasons of scarcity, they fall back on the edible fruits, roots, and plants of the forests to keep body and soul together. For example, among the Konds, the summer, which is a season of scarcity, is known as *sukki kalo* or hungry season. Products of the jungles, *e.g.*, yams and other edible roots, dry *mohua* fruits, mangoes and mango stones ground to a sort of flour etc., pull them through the *sukki kalo*. In 1868, there was a widespread famine in Central India, during which the Gonds and other aboriginal tribes were but slightly affected, because (*i*) they could rely on the products of the jungles, and (*ii*) the light millet crops, *Kodon* and *Kutki*, were not so badly affected by the failure of rain. Among the Lushai Kukis, in times of scarcity, whatever rice can be had is reserved for the young children, while the rest of the people live on wild yams, vegetables, and the pith of the sago palm. But the importance of the collection of forest products, as a method of securing food in primitive tribal life has been greatly reduced by the reservation of forests by the Government. I am informed by Mr T. C. Das of Calcutta University that he has come across one small tribe, the Chiru, belonging to the Kuki group and inhabiting the eastern fringe of the hills bordering the western side of the Manipur plain, who, when questioned about what they would do in case of a failure of crops, did not say anything suggesting the importance of the collection of forest produce in scarce times. On being given a broad hint about wild fruits and roots, they mentioned only a few wild roots that could be collected. This may be explained on two grounds, - (*i*) their natural environment is not rich in wild edibles, and (*ii*) the possibility of borrowing from the plains people with whom they are in contact.

In former times hunting and fishing played a very important part in the economic life of the primitive tribes of India. They were once the primary occupation of many of these tribes, *e.g.*, the Mundas, Santals and Gonds. To-day all of them are concentrating on cultivation. But till recently the contribution, made by hunting and fishing, to the food-supply of the primitive tribes has been considerable. Now-a-days, however, the reservation of forests has diminished the importance of hunting to a very great extent. For example, the Konds, Gonds and Baigas have been deprived of one of their main sources of livelihood. In connection with hunting it should be noted that the ancient bow and arrow is being replaced by flint-lock guns wherever the tribes have come into possession of a few of them. This is the case with the Gonds, Lushai Kukis, Angami Nagas etc.

Cultivation, which is the main source of food-supply to the primitive tribes under consideration, is of two kinds, shifting and fixed, or dry and wet. The shifting system of cultivation is known by different names among different tribes. It is called 'jhum' by the Assam tribes, 'bewar' by the Baigas, 'dahia' by the Gonds, 'podu' or 'kumeri' by the Konds, and 'kurao' by the Maler in the Rajmahal Hills. The fixed cultivation is like the usual plough cultivation of the Hindus of the surrounding plains. The two systems of cultivation play different roles in the economic life of different tribes.

The Maliah Konds, Maria Gonds, Hill Garos, Lushai Kukis and Lhota, Sema and Ao Nagas practise only the shifting system of cultivation. In this system a patch of jungle on the hill slopes is cut down in the winter, and left to dry in the sun. In the summer the dried logs and branches are set on

fire, and the ashes scattered all over the ground. When the rains commence, the seeds are sown broadcast in the ashes with or without hoeing. These patches are cultivated for 2 or 3 years, and then left to lie fallow till they are recovered with jungles. The number of years for which these patches are left fallow also depends on the availability of jungle land and the density of population.

The tribes living in or near the plains, and in contact with the plains-dwelling Hindus, are adopting the fixed system of cultivation. Such are the Konds of the lower slopes, the majority of the Gonds, the Mundas, Santals, Garos of the plains, Khasis and Angami Nagas. It may be mentioned here that the Chakroma Angamis, though they live nearer to the plains than other Angamis, have so much good *jhum* land, that they depend only on 'jhuming' for their livelihood.

The fixed cultivation of these tribes may be sub-divided into dry and wet cultivation. The former is practised by the Gonds, Mundas and Khasis ; and the latter by the Konds of the lower slopes, Santals, Mundas, Angamis, Plains Garos, and Khasis. The Mundas and Khasis practise both dry and wet system of fixed cultivation.

The dry cultivation is carried on by the Gonds in hilly and jungle tracts of poor quality, consisting of *barra* or gravel soil disintegrated from the rock of the hill-sides, by the Mundas in their *danr* or *tanr* (uplands), and by the Khasis in their *Ka ri lum* or *Ka ri phlang* (high grass land). The wet cultivation is carried on in terraced low lands and valley bottoms, which are called *don* by the Mundas, and *hali* or *pynthor* by the Khasis.

All the primitive tribes under consideration, with only three exceptions, use the plough in their fixed cultivation of both dry and wet kinds. The Kutiah Konds, *i.e.*, the Hill Konds of Kalahandi, a State in Orissa, in rare instances, grow a little wet rice. When they do so, they use neither the hoe nor the plough in preparing the field, but manual and pedal labour of men, women and children. The Angamis dig their terraced fields with a spade which has the shape of an inverted V and a flat spoonlike blade 6 to 8 inches broad in the broadest part. The Khasis use a hoe for the purpose, though the Syntengs, one of the Khasi tribes, in the neighbouring Jaintia Hills employ the plough.

The cultivation of these tribes is mainly dependent on rainfall. But the Angamis, Khasis, Mundas, Santals, and Konds of Ganjam supplement rainfall by artificial irrigation, which takes the form of *bandhs* or embankments across ravines, hollows or other natural depressions to retain natural moisture. The Santals exhibit much ingenuity and co-operative effort in constructing *bandhs*. The Angamis and Khasis are more ingenious in artificial irrigation. They irrigate their terraced fields by skilfully contrived channels drawn from streams, sometimes at a distance of a few miles.

The crops cultivated are usually cereals, pulses, oil seeds, and vegetables. Rice is the staple crop among the tribes of Assam, Chota Nagpur and Santal Parganas. The Gonds, Baigas, and Kutiah or Maliah Konds depend on small millets called *kodon* and *kutki*. It is not long since the cultivation of potatoes was introduced among the Khasis, but they already excel in it. Among fruit crops, the cultivation of oranges by the Khasis is noteworthy. The export of Khasi orange, under the name of Chhatak or Sylhet orange, to the markets of Bengal has been going on for generations. According to Sir George Birdwood, the orange and lemon of Garhwal, Sikkim and Khasis have been carried by Arab traders into Syria, "Whence the Crusaders helped to gradually propagate them throughout Southern Europe."[1]

The domestic animals found among these tribes are cows, buffaloes, mithans, pigs, goats, fowls, dogs, cats etc. The chief animal among the Angamis and Lushai Kukis is the mithan, while that among the Mundas, Santals, and Konds is cows and buffalos. The main economic importance of the domestication of animals among the primitive tribes of India consists in supplying them with their protein requirements in the form of meat. Other economic uses of domestic animals are ploughing, trading, hunting and scavenging. A number of Syntengs in the Jaintia Hills depend on cattle-breeding for their livelihood. The Angamis sometimes rear mithan for sale. The Mundas, Santals and Konds use oxen and buffaloes in ploughing. Dogs are reared by the Angamis and Lushai Kukis for hunting purposes. Pigs are the first-class scavengers of the villages of the hill tribes of Assam, and contribute much to their sanitation. Dogs also play their part in scavenging the villages. Apiculture or the rearing of bees is found among the Khasis and the Angami Nagas.

The arts and crafts found among these primitive tribes are spinning, weaving, basketry, pottery, carpentry, blacksmithy, iron-work, brass-work, oil-pressing, salt industry, and dyeing. The majority of the above arts and crafts are practised by the Mongoloid tribes, whereas the Pre-Dravidian tribes are very poor in this respect. The Gonds and Konds have no handicrafts, their industrial requirements being supplied by low-caste Hindus settled in their villages. The Mundas have only spinning and oil-pressing. It should be noted that the art of oil-pressing is present among the Pre-Dravidian tribes,

[1] Sir George Birdwood—Introduction to the "First Letter Book of the East India Company", p. 36.

but absent among the Mongoloid Indo-Chinese tribes, except the Kacharis. I am indebted to Prof K. P. Chattopadhyay of Calcutta University for the information regarding oil-press.[2] The Mundas have a strong prejudice against weaving, which they regard as a degrading occupation, only fit for the Panos (a Hindu caste) of the village. The efforts of the Roman Catholic Mission to introduce weaving among the Mundas have proved a failure. The Santals have no specialized crafts, and buy their industrial requirements from the Hindu artisans. According to Man, writing in 1867, the Santals "have weavers from their own tribe", and "each man is his own carpenter."[3] But according to Dalton, writing in 1872, "They have no weavers among their own people."[4]

Of the Mongoloid tribes, the Garos and the Khasis (proper) are rather poor in arts and crafts; but the Angami Nagas and Lushai Kukis are richer in this respect. The Khasis proper are entirely unacquainted with the art of weaving, though it is known in the neighbouring Jaintia Hills where the spinning and weaving of both cotton and silk are found in a few villages. The Khasis knew the art of excavating and smelting iron ore, and the forging of iron implements therefrom. But this industry, together with the cotton-spinning industries at Mynso and Suhtnga in the Jaintia Hills are dying out, as a result of competition from cheap British goods of iron and cotton. The Angami Nagas, before their conquest by the Government used to manufacture salt from brine wells. This salt industry has now almost gone out of use. The moulding of brass and the forging of simple iron implements, found among the Lushai Kukis, has been introduced, according to Shakespeare, by the raid captives from the plains of India or Burma.

The influence of the physical environment on the economic life of these tribes in general, and the method of procuring food in particular is obvious. All these tribes live in well-wooded hilly tracts rich in all kinds of forest products and game. Consequently they show similarity in the method of procuring food. For, they are mainly collectors of wild edible fruits and roots, hunters and shifting cultivators. But where there are open plateaus, as in Chota Nagpur and the central plateau of the Khasi Hills, we find fixed cultivation. This is the case with the *danr* and *don* lands of the Mundas, and high grass land (*ka ri lum*) of the Khasis. But in the forest tracts of the Khasi and Jaintia Hills the Bhois, Lalungs and Lyngngams still practise jhum or shifting cultivation.

The influence of the physical environment is also to be observed in the details of technique. For example, the Mundas and Khasis practise dry cultivation in their highlands, and wet cultivation in lowlands. This influence may be noticed even in the method of sowing. For instance, the Mundas have *buna* or sowing broadcast for their *danr* lands, and *ropa* or transplantation for their *don* lands in the bottoms of valleys.

But the influence of the physical environment is not omnipotent and determining. It sets certain limits within which there is scope for variations. For example, in the fixed cultivation of the wet type, the Mundas and Santals use the plough, whereas the Khasis and Angamis have no plough and employ the hoe, though the physical environment is about the same. Again, though the Khasis proper do not use the plough, the Syntengs in the neighbouring Jaintia Hills use it in their wet cultivation. (I am told by Mr. T. C. Das of Calcutta University that nowadays the Khasis also are adopting plough cultivation in the lower valleys). It seems that these variations are due to separate cultural traditions. The point may be further illustrated by the fact that while the Angami Nagas and Lushai Kukis build their villages on tops of hills, the Khasis choose sites a little below the tops, and the Garos prefer the valleys or depressions between hills for their village sites. In the case of the first two tribes, living in the midst of peoples fond of raiding each other, the consideration of security determined their selection of the hill tops. But the choice of the Garos was influenced by the proximity of the source of water-supply.

Now, I shall consider the question of labour. There are some ill-informed people who seem to think that the primitive tribes are very lazy and that most of their miseries are due to that fact. This is very far from the truth. The primitive tribes are by no means averse to hard work. As a matter of fact, they have to work very hard, in the face of serious dangers of attacks by wild animals infesting the dense forests, merely to keep their body and soul together. The cutting of a *jhum* or *bewar* or *podu* is a difficult as well as dangerous task. The reclaiming of land from jungles for plough cultivation is a very hard job, and the Santals have acquired great skill and fame in that work. The terracing of hill-sides, embanking and irrigating them, to make them fit for wet rice cultivation, requires an enormous expenditure of energy, and the Mundas, Santals, Khasis, and Angamis have been performing this arduous work for generations.

[2] K. P. Chattopadhyay—"Indian Oil Presses and Oil Extraction". *Journal of the Indian Anthropological Institute*, Vol. I, Nos. 1 & 2, 1938.

[3] E. G. Man—Sonthalia and the Sonthals, Calcutta, 1867.

[4] E. T. Dalton—Descriptive Ethnology of Bengal, Calcutta, 1872.

Work among the primitive tribes is not undertaken indiscriminately. There are certain traditional principles according to which labour is divided. The main basis for the division of labour among these tribes is sex. The functions usually reserved for women are the collection of edible fruits, roots and plants from the forests, cooking and other domestic work, ginning cotton, spinning, weaving, and pottery by hand. Among the Sema Nagas and Changs pottery is done exclusively by women, though among the Angami Nagas both men and women take part in it. The functions usually reserved for men are hunting, fishing, warfare, basketry, carpentry, house-building, and metal work. Cultivation is usually shared between the two sexes. Heavier tasks like jhum-cutting, ploughing, constructing *bandhs* and irrigation channels are left to men, whereas women participate in transplanting seedlings, sowing, weeding, harvesting and threshing. (I am indebted to Mr. T. C. Das for the information that jhum-cutting among the Naga and Kuki tribes is shared between the two sexes; big trees are cut by men, and small brushes by women). Among the Mundas, who use bullocks in threshing, it is done by men. Munda women watch the ripening crops in day time, while men keep watch at night. Sometimes women take part in hunting and fishing. Among the Garos, in big hunting drives, women line the outside of the V-shaped stockade, and by beating it with sticks and uttering shrill cries, help in preventing the animals from escaping except through the openings made for them. Garo women also fish with the *chekke*, a scoop-like basket. In the excavation of iron ore by the Khasis, women do the washing of the ore in a trough.

The principle of sex division is sometimes extended to the field of fine arts. The Jew's harp is practically the only musical instrument that women can play among the Angami, Sema and Lhota Nagas. Among the Semas, the flute is a taboo to the women, and is played exclusively by men. Incidentally, it may be interesting to note here that the Hindu womenfolk of Bengal have a prejudice against the flute, and that if they (married women) hear the sound of a flute while having a meal they would immediately stop eating and go without anything till the next meal.

The principle of dividing labour on the basis of age is not much in evidence. A few cases may be noticed. Among the Gonds the task of watching the ripening crops is left to the old men and children. Among the Kutiah Konds, the children along with their mothers, puddle their wet fields with hands and feet. The Lushai Kukis are assisted in their cultivation by the children. Little Lushai girls help their mothers in bringing up water in bamboo tubes from the springs. Among the Angami Nagas, only old men are entitled to manufacture wooden dolls.

Division of labour according to crafts or occupation is absent among the Pre-Dravidian tribes. Only rudiments of such division are found among the Mongoloid tribes. For example, among the Angamis, every large village has at least two or three individuals who live either entirely or mainly by blacksmithy. Among the Lushai Kukis, every village has a blacksmith who is also one of the village officials, and is paid at the rate of one basket of rice from each householder whose tools he repairs. Some Angami villages keep a regular cowherd who is to look after the cattle of the village, and who is paid at the rate of two baskets of paddy per annum per cow by the owners of the cattle under his charge.

The principle of specialization according to locality, though in a rather elementary form, is found among the Khasis. For instance, among the Syntengs in the Jaintia Hills, the Khyrwang and Nongtung villages specialize in the manufacture of Eri silk cloths, Mynso in spinning cotton thread, and Suhtnga in weaving the *ingki* or sleeveless coat from Mynso thread.

The division of labour according to ethnic groups is present among some Pre-Dravidian tribes. For example, the Gonds and Konds devote themselves to collecting, hunting, fishing and cultivation, while low-caste Hindu artisans, resident in their villages, supply them with their industrial requirements. The Sittras are the metal-workers of the Konds. They make their battle-axes, brass ornaments, etc. The Panos are the weavers of the Konds, sometimes work for them as agricultural labourers, and provide them with salt and many other necessities.

Primitive labour in India presents another feature, and that is co-operative work. All forms of economic activity among the primitive tribes provide ample instances of the principle of co-operation in labour. Let me take a few cases. Among the Konds, in the hot weather when food-supply gets low, and people have to depend more on food-gathering for subsistence, young men and women form parties for fishing and the collection of mahua fruits and other jungle berries. In the collection of wild honey from the bee-hives in the crevices of precipitous rocks, the Khasis form working parties of six or seven persons. An excellent example of co-operative labour is supplied by the institution of age gangs among the Sema Nagas. Every member of a village, old enough to be independent of the care of the mother, belongs to a gang consisting of persons of about the same age. Gangs of unmarried persons are usually mixed, whereas a married person belongs to a gang of his or her own sex. The cultivation of the fields is done by these gangs, whose membership usually lasts for

life. Each gang elects its own leader who decides what fields are to be cultivated each day. Every member of a village can depend on his gang for the cultivation of his fields, the conventional remuneration of gang labour being rice and liquor.

Co-operation in hunting is very well-illustrated by the Santals, Angamis, Lushai Kukis and Garos, who organize large hunting parties where whole villages take part. During the hot weather, from the middle of April, the Santals organize big hunts in which every able-bodied man in a *pargana* or a group of villages, tries to participate. These hunts are very well organized. A common Santal is democratically elected to be the priest, sacrificer and master of the hunt, and is called *dihri*. The dihri fixes the time and place of the hunt, and also the place where the whole party is to assemble and spend the night. These hunts are of great importance not only economically, but also socially and politically. For, in the night, these hunting parties form a hunt-council under the presidency of the *dihri*, which is the supreme authority in the *pargana*, and where all important issues concerning the life of the people are raised, discussed and decided upon. It is in these councils that *manjhis* (village headmen) and *parganaits* (heads of *parganas*), who abuse their position in their selfish interest, can be brought to justice. It is through these hunt-councils that the voice of the people speaks, and democracy is translated in vigorous action.

The principle of co-operation in cultivation, shifting as well as fixed, can be illustrated by the practice of the Angamis and Santals. In those Angami villages where jhuming is practised, it is the custom for the whole village or at any rate the clan to jhum collectively. There is no case of an individual household jhuming an isolated patch. Again, in digging and puddling wet terraced fields, an Angami receives help from his friends or kindred, each going to work in the fields of those who helped him. In such cases of co-operative labour, payment is made, in the form of a mid-day meal, by the owner of the field on which work is being done at the moment. A very good example of co-operation in cultivation is given by the Santals. The enormous task of constructing, maintaining and repairing large *bandhs* or embankments for irrigation purposes, which is far beyond the means and enterprise of the individual, is performed by the entire village community, and every member of the community shares in the resultant benefit.

The next question to be discussed here is whether the institution of slavery exists among the primitive tribes of India. Before I answer this question, I would explain the socio-economic significance of the institution. Slavery is a quantitative division of labour where some people are compelled to labour for others, and the whole personality of the forced labourer is completely absorbed. This is the sense in which the term slavery has been used by Fuchta and Nieboer among others. Nieboer defines the slave as "a man who is the property or possession of another man, and forced to work for him".[5]

The insitution of slavery exists among the Mongoloid Indo-Chinese tribes, though it is conspicuous by its absence among the Pre-Dravidian tribes. For example, the Angamis enslave the prisoners of war. Among the Lushai Kukis, persons captured in raids who are called *sal*, are the property of the captors. The *inpuichhung boi* of the Lushai Kukis, *i.e.*, widows, children and others incapable of maintaining themselves, who take refuge in the chief's house, and do all sorts of manual work for him, *e.g.*, domestic work, jhuming, fetching wood and water, making cloths etc., in exchange for food, clothing and shelter, can be classed as slaves with two limitations. The first limitation is that they are free to move from one chief's house to another, and the second is that they can purchase their personal freedom by paying one mithan or its equivalent in cash or goods. Even when they purchase their freedom they are known as *inhrang boi*, and are compelled to give the chief a hind leg of any animal they kill, and help him if he is in want of rice. An *inhrang boi* also can go to the chief for assistance when in want. Incidentally, it may be mentioned here that the custom of *inpuichhung boi* of the Lushai Kukis serves as a sort of social security for the helpless members of the community. Among the Khasis, the punishment of the convicts sometimes leads to the confiscation of their property and personal freedom, and the enslavement of the convicts and their families by the Siem or Chief. The slaves among the Garos are called *nokol* as distinguished from the *nokoba* or freemen. But the Mundas, Santals, Gonds and Konds do not show any trace of slavery. The meriah victims of the Konds cannot be regarded as slaves, as they are not forced to work.

In connection with slavery, one correlation is noteworthy, the correlation between slavery and the institution of chieftainship. These two institutions seem to go together. The Mongoloid Indo-Chinese tribes have both chieftainship and slavery, whereas the Pre-Dravidian tribes have none.

The last point to be considered in this chapter is the organization of production. Though in the final analysis the family or household is the basis of such organization, it carries on productive activities, not in isolation or as it pleases, but in the broader framework of the village organization. The basis

[5] H. J. Nieboer—Slavery as an Industrial System, 2nd edition, Hague, 1910, p. 8.

of this village organization is, among the Mongoloid Indo-Chinese tribes, more or less authoritarian chiefs assisted by nominated village officials, while among the Pre-Dravidian tribes it is the democratic village community with elected headmen and other officials. For example, among the Lushai Kukis, each village is ruled by a *lal* or chief. He appoints one or more *upas* (elderly councillors) and a number of village officials—*ramhual* and *tlangau*—to assist him. The function of the *ramhual* is to select the place for jhuming, and he has the first choice of land for the purpose. The *tlangau* arranges the division and allotment of the work of the village, e.g. making a road, repairing the *Zawlbuk* (bachelors' hall) etc. The *tlangau* is paid for his organizing work with a small basket of rice from each house in the village. Coming to the Pre-Dravidian tribes, the village community of the Santals, and the *parha* and *muta* organizations of the Mundas and Konds respectively are very similar to each other, and represent excellent examples of a compact, well-organized, democratic village community. To take the case of the Santals. Every Santal village has a *manjhi* (headman) and six other elected officials. One of these officials—the *paramanik*—may be called the economic organizer of the village. His duties include attending to farming arrangements, apportioning lands, preventing the monopoly of specially fertile rice lands by any one individual or individuals, looking after the interests of new settlers, providing for guests, and levying contributions on the villagers for the last named purpose. All these officials are remunerated by *man* or rent-free land. The Santals have a tradition of an annual ceremony in the month of *Magh* when all the village officials surrender their offices and lands to the people of the village. A week later, they stand for re-election and are usually accepted.

Notes and News

TECHNICAL MISSION ON FERTILIZERS

The Technical Mission on Fertilizers from United Kingdom, headed by Mr G. S. Gowing, has arrived in India. The purpose of the Mission, it is understood, is to advise the Government of India on the manufacture of chemical fertilizers in this country. Immediately after its arrival at Delhi, the Mission is reported to have met in a conference with members of the Reception Committee constituted by the Government to place at the Mission's disposal all available data in this connection. The discussions centered round the technical aspect of the question of soil survey, availability and utilization of raw materials and power and questions of the manufacture of ammonium sulphate and ammonium nitrate. The question of the proper location of fertilizer industry was also discussed, but no decision is reported to have been reached. We also understand that no commitment has yet been made on financial question. It appears, so far as it can be guessed, that the enterprise will be a Government one financed jointly by the Central and Provincial Governments and the States.

The Mission has left Delhi for a forty-day tour in various places of India, which include Patna, Calcutta, Cuttack, Tatanagar, Dhanbad, Madras, Mysore, Bangalore, Hyderabad and Bombay and is expected to return to Delhi on August 4.

In our editorial article of the June issue of SCIENCE AND CULTURE, we already expressed grave doubts as to the wisdom of inviting such technical missions of foreign experts for short commissions. During recent years it has become a fashion with the Government of India to invite foreign technical missions to advise us on technical matters. The activities of the U. S. Technical Mission headed by Dr Henry Grady, which visited this country during April and May, 1942, are still fresh in our memory. In fact, we object to the practice of inviting scientific, technical, or economic missions, partly or wholly composed of foreigns, on principle. No such procedure is adopted in any independent country. When a country like, say Sweden, wants to take advantage of some technical process or scientific discovery elaborated in another country, say U. S. A., it forms a scientific mission of its own scientists and sends them to the foreign country to establish contact with the parties concerned who may be Government Departments or manufacturing concerns. The scientists so chosen need not be experts on the particular subject, but such as are able to understand the processes and carry on the talks and conversations. Such a system has great advantages. The mission is guided entirely by the countries' interest, and gains an experience which is valuable for the country and may be utilized on all subsequent occasions.

This time the very technical competence of the experts, all foreign, constituting the Mission has been called into question. In India, a fertilizer plant has already been built in Mysore and is being successfully operated by Mysoreans, thanks to the initiative, foresight and zeal of her statesmen. The unpleasant fact of the exclusion of Indian experts from the Mission has been knaively concealed under cloak of of the newly created Reception Committee composed of Indian members whose chairman, Sir James Pitkeathly, is again a non-Indian. The Reception Committee, although a novel device, is a superfluous creation and was never heard of in India before.

The experts of the foreign mission have not come on philanthropic mission ; they have the commercial interests of their own country or employer in view. Further, their interest is only temporary, and after they submit the report which, as in the case of most reports, will soon be forgotten by every body and probably eaten by white ants in the Delhi archives, they will have forgotten everything about their own recommendations.

LONG-RANGE WEATHER FORECASTING

Dr Charles G. Abbot, Secretary of the Smithsonian Institution, in course of his recent Twelfth Arthur Lecture, discussed the possibilities of long-range weather forecasting from a study of the variations in solar energy received by the earth. It is well-known that the earth, at a distance of 93,000,000 miles from the sun, is incessantly receiving solar energy equivalent to 250,000,000,000,000 horse-powers. The rate of reception of this radiation is not steady, but it fluctuates in a peculiar way of which the cause is still imperfectly understood. The variation is characterized by cycles or rhythmic curves, of which Dr Abbot has identified not less than 14. It seems highly probable that such fluctuation in solar radiation is directly related to the sun spots. Each sun spot pours out a great conical spray or jet of electrically charged particles which sweep in vast circles as the sun makes its 27-day revolutions about its axis. The radiation from the sun suffers scattering from these particles and hence a loss of intensity in a particular direction. Loss of intensity on the earth, which generally lies between 1 to 5 per cent., takes place when such a spray sweeps across the earth.

Dr Abbot has applied the knowledge of the variations in solar radiation to the study of the meteorological conditions on the surface of the earth and has made a number of successful trial forecasts during recent years. Mention may be made of his prediction that the rainfall in the Tennessee Valley during a given three-month period would be between 84 per cent. and 87 per cent. normal. Later measurements during that period, when it came, indicated a rainfall of 87 per cent. normal. In connection with his another experiment on weather forecasting for Washington, D.C., he informed the Chief of the Weather Bureau that in a certain list of dates in 1943 the average daily precipitation would be higher than on the remaining dates of the year. The selected dates were expected to show 1·66 times the average rainfall of the non-selected dates. The actual ratio, for the 175 selected dates compared to 191 non-selected ones, proved to be 1·58, which is a satisfactory agreement. Dr Abbot has made another interesting long-range forecasting that great droughts resulting in the serious lowering of water level in the Great Lakes will come to pass in the North-West in the years 1975 and 2020.

T. V. A. ELECTRO-CHEMICAL INDUSTRIES

The great progress of the electro-chemical industries associated with the hydro-electric plants of the Tennessee Valley Authority has been outlined in the annual report of the Authority, issued recently. This progress is due mainly to the substantial increase in the output of electric power which now amounts to 9,000 million units compared to 5,556 million in 1941, as recorded in an earlier issue of our journal (Vol. IX, No. 10). Three-quarters of this power is now used for war purposes. The fertilizer plant at Muscle Shoals is now producing large quantities of ammonia and ammonium nitrate for explosives, elementary phosphorus for incendiary bombs and smoke screens and carbide for synthetic rubber. It is stated that 13,600 tons of ammonium nitrate were diverted from military allocation to civilian use as fertilizer. 60,200 tons of concentrated super phosphate and 7,300 tons of calcium metaphosphate were produced during the year ended June 30, 1943. We further understand that TVA has planned to produce 15,000 tons of dicalcium phosphate, which will be used to replace bone meal in farm animal feed. TVA fertilizers containing the optimum amount of phosphorus have been found to increase the crop yields on experimental farms by 30 per cent. It has been estimated that if the yield of crop is to be similarly increased throughout U.S.A., her present production of 1,712,000 tons a year will have to be doubled.

A TESTING LABORATORY IN SOUTH AFRICA

The recent recommendation of the South African Standard Institution, according to a report in *Science*, for the creation of a National Standards Testing and Investigational Bureau to be set up by the Government bears testimony to the increasing recognition of the importance of science in South

Africa. Such a bureau would act as a national standardization laboratory and would carry out or arrange for investigations and tests in connection with standardization. Its functions would include the testing and calibration of precision instruments, gages and scientific apparatus, the determination of the degree of accuracy with regard to fundamental standards and finally the preparation of certificates.

Testing and investigations on behalf of the South African Standards Institution and others would be done either by delegating the work to approved institutions or by providing laboratory facilities. Such testing would include physical or chemical examination of materials and products and tests of their use and performance.

The bureau would also assist the South African Standards Institution in investigating any questions affecting the preparation of its standard specifications. It would provide facilities for testing goods, articles and materials purchased on specification to decide whether such materials comply with the specification, and would act on behalf of the Government in testing locally manufactured and imported goods with a view to determining whether the goods comply with the regulations laid down by the Merchandise Marks Act or any other act and to verify standards. It would also test manufactured products and carry out investigations and inspections to enable the South African Standards Institution and other standardizing bodies to control their marks. In addition to all this, it is suggested that the bureau would also assist the Government departments in any tests which may require to be undertaken.

BRITISH RADIO RESEARCH INSTITUTE

According to a report of *Nature*, March 18, 1944, the British Institution of Radio Engineers has recently recommended the creation of a British Radio Research Institute. The need for such an institute is now urgently felt in that country in view of the lack of opportunity for conducting basic research in radio and electronic sciences. At present research is mainly concentrated on short-term problems with promise of immediate practical applications and early financial returns. Facilities for long term fundamental research with no such immediate prospects are now available with difficulty owing to financial limitations. Accordingly the Institution advocates the formation of a Radio Research Institute to provide facilities for the equally important basic research in radio and allied sciences. It is suggested that such an Institute, when created, should be financed jointly by the industry and the Government, the latter providing grants of at least equal amount. The board responsible for the direction of the Institute's work should consist of the representatives of the Government, the industry, the B.B.C., the Services, the British Institution of Radio Engineers, the associated professional institutions and the universities. It should have a permanent scientific staff and should receive the co-operation of the industry and the universities in the matter of assistance and engagement of extra-mural workers. Another important suggestion is that the institute should extend to all countries within the Commonwealth opportunities for participation in its research work.

Thanks to the impetus of the war, the radio has already developed into a highly important industry. It is reasonable to expect that in the post-war period the radio industry will supply capital goods on a scale equal to many of the older industries. Benefits derived from research associations in other branches of development encourage the hope that the radio industry will be similarly benefited by the formation of a Radio Research Institute of the type contemplated. It is further stated that if the present turnover for the radio industry be assumed to be about £20, an allocation of only 0·25 per cent., with Government grants, will produce an income comparable with that of other research associations.

ALL-INDIA RADIO

The All-India Radio has recently issued a report on the progress of broadcasting in India during the five years of existence of the war. Since its publication of the first comprehensive report in 1940, covering its activities up to April 1939, the A.I.R. has undergone several vital changes and great expansion in its activities, thanks to the exigencies of the war. Although originally designed for internal services, the A.I.R. no longer confines its activities within the borders of this country, but has extended its field of broadcasting services beyond her frontiers to the four continents of the world. Up to 1939, it maintained a basically internal service and operated from its eight stations and thirteen transmitters. The A.I.R. now controls twenty transmitters, of which the latest to be installed were two high-powered 100 k.w. short-wave transmitters capable of direct point-to-point transmission from Delhi to London.

But the setting up of the Broadcasting House in New Delhi in place of the Studios in Old Delhi marks the most significant advance in the great development of the broadcasting services with which A.I.R. is now credited. Although the construction of the House was long under contemplation, it was postponed for an indefinite time. The construction of the building became inevitable when the A.I.R., under the pressure of war, had to take the vital decision of installing the high-powered transmitters. Architecturally and from the view point of equip-

ment, the Broadcasting House represents the latest developments in radio-engineering. Of twenty transmitters today, Delhi alone has a concentration of nine, including the high-powered 100 k.w. short-wave transmitters. All these developments at Delhi have made possible the centralization of the news service, with the result that all special facilities required for rapid and efficient broadcasting of news have been concentrated at one point.

The technical expansion has brought about a rapid growth of the A.I.R.'s activities on the programme side. Within a month of the outbreak of hostilities, the total transmission output from all A.I.R.'s stations increased from 45 hours to 75 hours daily. The extent of its expansion is further reflected from its programme contents which include, besides the normal mainstay of musical entertainment, news in nine Indian (and fifteen non-Indian) languages, news commentaries, talks—topical, informative and cultural—features, plays special programmes for schools, universities, villages and industrial areas, women's and children's hours and broadcasts for Indian, British and American forces. The relations between A.I.R. and B.B.C., always cordial—have become more closer than ever. From September 2, 1939, A.I.R. began the daily relay of B.B.C.'s 9-30 p.m. (I.S.T) news bulletin broadcast by the Central News Organization as an organic part of its news service. On request from B.B.C., special broadcasts have been prepared and transmitted for rebroadcast from London. Studio and transmission facilities are given to B.B.C.'s news correspondent in India. The report further records greater co-ordination between various stations.

While we appreciate the amount of progress made by the A.I.R. during the last five years, our attention is drawn to the significant proposal by the British Institution of Radio Engineers for the creation of a Radio Research Institute in Great Britain. The need for the creation of a similar Radio Research Institute in India is also strongly felt in India and it is high time that this problem should receive the serious attention of Indian scientists, the industrialists and the Government.

INDIAN WATERWAYS EXPERIMENT STATION

THE name of the Central Irrigation and Hydrodynamic Research Station, Poona, has been changed into "Indian Waterways Experiment Station", according to a notification published in the Gazette of India. The Station, recently put on a permanent basis by the Government of India, was originated 24 years ago under the Bombay Government at Poona by Mr C. C. Inglis, then Executive Engineer, Special Irrigation Division. In its early days, experiments were conducted at Hadapsar with models designed to solve various hydrodynamic problems concerning irrigation in Bombay and Sind—specially in connection with the design of the Sukkar Barrage Scheme and the Deccan Canals, then being constructed.

In 1925, it was found that the discharge available at the Station was insufficient for carrying out several large-scale model experiments simultaneously; and, as exceptional facilities existed at Khadakwasla situated about 11 miles from Poona, where water could be drawn straight from Lake Fife, new models were constructed there. In 1934, the original Station was totally transferred to Khadakwasla, where it has been working ever since. In 1937, it was taken over by the Government of India to serve the whole of India. Mr Inglis was appointed its first Director, a position which he still holds.

The outstanding features of the Station are that there are 11 independent sources of supply, the discharge of each of which can be maintained absolutely constant; no pumping is required; water is free from sand and is normally clear except during floods in July to September, and the temperature of the water is constant throughout the day and varies very little throughout the year. The Station comprises an area of 16 acres. Twelve models are normally under investigation at the same time, in addition to some 20 demonstration models.

During the last 7 years, over 100 important investigations have been carried out at the Station. These included the protection of bridges over rivers and the prevention of excess sand entering canals. This was applied in many cases, the most important being the right bank canals at Sukkar which were rapidly going out of service due to the excessive charge of bed sand entering them. River training in tidal and non-tidal waters was another important line of research, and a number of important principles have been established in connection with the value of attracting, deflecting, and repelling spurs for controlling rivers, the factors determining the size and shape of meanders, the relation between rainfall and run off, the effect of silt washed into rivers when hill denudation occurs, and the rate of silting of reservoirs.

INDIAN INSTITUTE OF SCIENCE

AT the Seventh Annual Meeting of the Court of the Indian Institute of Science, Bangalore, held on July 3, 1944, Sir M. Visvesvaraya, President of the Court, while presenting his opening address, said:

"There have been two notable developments during the past year. One is the institution of aeronautical and automobile engineering sections in

the Institute for which the Government of Mysore has sanctioned a capital grant of Rs. 1 lakh and an annual recurring grant of Rs. 15,000. An additional grant of Rs. 2 lakhs for laboratory equipment in aeronautical engineering has been sanctioned by the Government of India. The second is the sanction, also accorded by the Goverment of India, of a further grant of Rs. 1,30,000 for a new department of metallurgy.* * *

The estimates of income and expenditure presented to the Court appear to be satisfactory. It may be of interest to the members to note that during the interwar period, 1919 to 1939, the average income and expenditure of the Institute remained practically stationary at about Rs. 6 lakhs. The increase which began in 1939 has continued and the actuals of income and expenditure from 1st April 1943 to 31st March, 1944 stand at Rs. 15,78,617 and Rs. 16,63,451 respectively. The estimates of income and expenditure for the session 1944-1945 is shown to be Rs. 19,27,378 and Rs. 21,76,535 respectively.

The opening balance of the new academic year —beginning from 1st July, 1944 available for ordinary expenditure stands at Rs. 4,91,799 and the closing balance on the 30th June, 1945 is likely to stand at Rs. 1,97,992. There is thus a decrease of about Rs. 3,90,000 expected in the opening balance. This decrease is due to the fact that the Institute has been financing, either wholly or partly, out of its own resources the following projects:—(1) New Departments of Aeronautical Engineering, Rs. 1,00,000; (2) Building a Dining Hall, Rs. 60,000; (3) Contribution to the Cosmic Ray Research, Rs. 40,000; (4) Air Raid Precaution Measures, Rs. 10,000; (5) Dearness Allowance during War, Rs. 40,000; (6) Financing Industrial Research as per item 14 of the Budget to the extent of Rs. 1,30,000. It may be added here that there is also a hidden reserve in the Suspense Account of the Institute to the extent of Rs. 78,000 which will eventually be transferred to the opening balance.

Several new schemes have been initiated since this Court met last year. The most notable feature of the year's history is that the Government of India which was giving only a fixed grant of Rs. 1,50,000 annually ever since the Institute was started in 1911, has this year increased the grant to Rs. 7,70,000.* * * I understand the Government of His Highness the Maharaja of Travancore has agreed to give a recurring grant of Rs. 3,000 from this year.

It is gratifying to learn that the income of the Institute from applied research is steadily on the increase. The actual income in 1943-1944 was Rs. 35,830 and the income expected from the same source in 1944-1945 is Rs. 80,000. The major part of this income has, I learn, been derived from the activities of the Biochemistry Department of whose work in this respect I may speak with high appreciation.

The subjects chosen for applied research were mainly suggested by the Board of Scientific and Industrial Research, the Imperial Council of Agricultural Research and by the War and Supply Departments.

The total expenditure is shown under items 14 and 17 of the expenditure head and it comes to approximately Rs. 1,76,000. This is exclusive of the expenditure and income which are brought under the head "Suspense" and used for the purpose of manufacture of war chemicals. This should normally be considered as research effort which gives pilot plant experience to workers.

The Director wishes the interesting news to be made known that the Institute has been able to produce the drug 'penicillin' from raw materials available in India by a method which is far less time-consuming than the standard methods. * * *

Some nine proposals have been put forward by the Joint-Committee for future development. I understand the proposals have been carefully considered and generally approved by the Council. The proposals are:—

(1) That plans and estimates be prepared with the aid of experts for bringing into existence a department of metallurgy (a very important development), and attempts be made to secure funds for the purpose;

(2) That a department of applied mechanics with special reference to the study of internal combustion engines, with a view to their manufacture in India, be started;

(3) That the department of aeronautical engineering be equipped and staffed on an uptodate and adequate scale;

(4) That the department of electrical technology be split into a department of electrical engineering which should progressively be converted into a purely research department, and a department of communication engineering, which will be a centre both for post-graduate teaching and research in radio communication;

(5) That the training course in chemical engineering be extended over six terms and that more adequate arrangements be made for imparting this training in the department of chemistry;

(6) That a central power distribution house

should be established in the Institute at an early date ;

(7) That a first class Research Workshop of Mechanical Engineering with a suitable staff attached to it, of fuel engineers, chemical engineers, mechanical engineers, and metallography experts who by close co-operation and intimate team-work would be able to solve the problem of design and construction necessary for the erection of industrial plants for various manufacturing processes which are now being developed in India, be created at the Institute and that this Workshop should be an integral part of the Mechanical Engineering Department ;

(8) That the possibility of opening a department of fuels and refractories be kept in view ; and

(9) The central services such as maintenance of lands and buildings, and maintenance of electrical installations, gas and water, and sanitary arrangemets should be placed under the control of the Registrar, the Council arranging for regular supervision by experts, who may be appointed from the members of the Institute and paid suitable allowances. (The object of this last change is stated to be that professors of the Departments should be relieved of the routine administrative duties in this connection and should thus have more time to devote to their legitimate work of research and teaching.)

I understand that the recent action taken by the Council leads one to hope that all the proposals with the exception of Nos. (7) and (8) embodied in this plan will soon mature. It is hoped that the other two items which are also of paramount importance will be taken up in the coming year.* * *

In 1938, the affairs of the Institute had reached a low ebb and the stagnation was mainly due to lack of funds. A Court formed a part of the Constitution but it never met. A President had been appointed who never presided. There was a Visitor who never visited. Now, however, although it is still war time, affairs seem to be brightening.

The chief cause which has contributed to this favourable turn is the raising of the grant of the Government of India which stood as already stated at Rs 1·50 lakhs for over 30 years to Rs. 7·70 lakhs for the first time.

It will not be superfluous to repeat, that this has been due to the happy combination of a sympathetic Chairman and members of the Council, the members of the Joint-Committee of the Court and of the Council, and the Director Sir J. C. Ghosh. The Joint-Committee appointed for the first time in March, 1940 under the Chairmanship of Sir V. N. Chandavarkar has done much valuable work. The members of the Joint-Committee who have given a generous measure of attention to this work have been besides Sir J. C. Ghosh, Sir V. N. Chandavarkar, Professor M. N. Saha. Principal G. R. Paranjpe and last year Mr J. Mohamed Imam and Mr S. G. Sastry. In the first two years of the working of the Joint-Committee, the services of Dr Syamaprasad Mookerjee were of special value."

PROF. B. B. RAY

We deeply regret to record the death of Professor Bidhu Bhushan Ray, Khaira Professor of Physics, Calcutta University on July 29, in his Calcutta residence at the early age of 50. Prof. Ray was associated with SCIENCE AND CULTURE from its very inception and the first issue came out in June, 1935 under his editorship. A detailed account of Prof. Ray will appear in the next issue.

AN ERRATUM

On page 10, column 1, lines 33 and 34 of July, 1944 issue of SCIENCE AND CULTURE, *read* one per cent. *for* ten per cent.

SCIENCE IN INDUSTRY

SYNTHETIC DRYING OILS

The use of tung oil as a natural drying oil is widely known. Although tung oil is the best of all natural drying oils, it suffers from a number of limitations, of which the most remarkable is its lack of uniformity. Considerable progress has recently been made in the development of synthetic drying oils which are now being increasingly used in place of tung oil with varying degrees of success. In fact, there are now strong evidences that in the post-war period paint and varnish industry will come to depend largely on synthetic drying oils, and the natural tung oil will be relegated to the background. In an able article on 'Post-War Developments in Synthetics', appearing in *Chemical and Engineering News*, January 25, 1944, J. Edmund Good, Vice-President of Woburn Chemical Corp., New Jersy, has summarized the present position with regard to synthetic drying oils, an account of which may be of interest.

It is now generally accepted that the characteristic properties of tung oil arise principally from the conjugated position of the double bonds in the tung oil molecule. This has been a most important study and has served as a guide in the development of the synthetic product in whose molecules the conjugated position of the double bonds has to be maintained. Drying oils have so far been successfully synthesized from castor oil, linseed and soyabeen oils. In these three cases it has been possible to introduce the double bond characteristics in their molecules.

The first successful attempt to produce the molecular characteristics of tung oil was made with castor oil which is a non-drying oil in its natural state. This has been effected by subjecting it to a process of dehydration, which consists in abstracting a molecule of water from the castor oil molecule. The method differs from the Scheiber process in the fact that the conversion is made without first converting the oil into a fatty acid and then esterifying the fatty acid. Dehydrated castor oil has proved a successful drying oil and has been received well in the industry.

Owing to the shortage of castor beans in U.S.A., normally importing this agricultural product from Brazil and India, attempt was recently made in that country to impart the tung oil characteristics to linseed and soyabean oils. An altogether different process is, however, followed in the conversion of these oils. Glycerol is first extracted from the molecules of both the oils. The linseed oil yields the Conjulin fatty acid and soyabean oil the Conjusoy fatty acid. These fatty acids are characterized by the presence of the conjugated position of the double bonds in their molecules. Either of these conjugated fatty acids may then be processed and esterified and the required drying oils obtained.

The Conjusoy drying oil derived from soyabean oil is as good as dehydrated castor oil in its resemblance with tung oil. It is colour-retentive to a high degree and retains the flexibility of dehydrated castor oil. Isomerized linseed oil, known as Conjulin drying oil, approaches tung oil more closely than has been possible for dehydrated castor oil or Conjusoy oil. Conjulin oil has its gel time slightly greater than that of tung oil, but has a greater water resistance, as has been indicated in numerous tests. Its film is tough and hard rather than brittle, and it retains flexibility. In the manufacture of insulating varnishes, wrinkle finishes and baked finishes of all kinds, isomerized linseed oil serves as a satisfactory substitute for tung-oil.

In addition to the dehydrated castor oil and isomerized linseed and soyabean oils which have reasonable chance of replacing natural tung oil in future, a number of less satisfactory synthetic oils have also been developed during recent years. Such synthetic drying oils include segregated fish oils, pentaerythritol esters, oils fortified with maleic anhydride and other dibasic acids, all of which have been used with satisfaction for specific purposes.

PREFABRICATED HOUSES

The introduction of prefabricated houses marks an important advance in building construction. Made in the factory, such houses are now being increasingly used for war purposes and bid fair to offer a satisfactory solution of the serious shortage of housing accommodation, apprehended at the end of the war. Even before the war, prefabricated houses are reported to have been used in America to house the large number of workers concerned in the great Tennessee Valley hydro-electric scheme. Some important constructional details of such factory-made houses, as they have been put up by one Uni-Seco Structures, Ltd. in Great Britain, have recently appeared in a short note in *The Chemical Age* (April 1, 1944), to which the attention of our readers may be drawn.

The case of single-storey houses with three rooms has been described. Erection time of such houses is about 730 man-hours, which means that a team of eight men requires less than two weeks. Such gain in time has been possible through the use of building units considerably larger than the units of traditional construction. The building units of which the walls are made measure 7 ft. 4½ in. by 3 ft. 2 in. and consist of a rigid insulating core of wood-wool bonded with cement and faced on both sides with flat edges by a light timber frame. Such units are claimed to be as good as 11 in. non-cavity brick wall so far as heat insulation is concerned. External joints between units are treated with a mastic compound to make them weather-proof. The floor units are made of resin-bonded plywoods ; the largest floor unit, with a span of 12 ft. 9 in., can be easily handled by two men, as can all other units, and components in such prefabricated buildings. The standard beams, columns, and eaves are also of stressed skin construction and built up of resin-bonded plywood firmly keyed to diaphragm spacing members. The use of plywood for the construction of houses was formerly discouraged owing to the failure of the glues to resist the action of weather or the attack of fungi. But the availability of glues conforming to such specifications as D.T.D. 484 has removed the difficulty of using plywoods which are now being used with great advantage.

Electric wiring and service pipes are easily installed and concealed in the ducts provided between, and at the end of, floor units. Plumbing is effected by a prefabricated vertical duct, passing from the kitchen through the first floor and connecting with a horizontal duct carrying the service pipes. Prefabricated houses are demountable, but can be used permanently if desired. Another encouraging fact about such houses is that the wastage involved during dismantling hardly exceeds 10 per cent. It is reported that during the last two years the company referred to has erected such houses on an area of about 50 million cubic feet at over 600 places in Great Britain.

USE OF BENTONITE IN FLUID FLOW ANALYSIS

THE varied responses of a flowing fluid to variously shaped obstacles like a boat hull, a heating pipe or an aerofoil form an interesting study but not a very exact one unless the directions of flow can be actually made visible. A new method of doing this, recently developed at the Massachusetts Institute of Technology, promises a real advance in the branch of hydrodynamics of fluid flow.

The method is similar to that in which engineers use "Polarized" light produced with optical equipment (analogous to that in "Polaroid" non-glare sun glasses) to render visible the strains in plastic models of solid structures like gears and other machine castings. When stressed, the plastic model deforms slightly and in so doing bends and twists the polarized light passing through it so that bends and splotches of colour show up at the points of strain. In the analysis of fluid flow, a suspension of bentonite (a non-refractory clay derived from the shale of the Fort Benton formation in the Upper Missouri Valley) in the fluid serves to modify the polarized light shining through the transparent walls of the experimental channel, just as the plastic modifies light in the analysis of strains in solids. The bentonite particles consist of platelets so small that they have no tendency to settle out of the suspension and so light that they move exactly where the fluid takes them showing substantially no inertia of their own. These physical and optical properties make bentonite superior to other substances used to trace out fluid flow, such as ink streams, smoke trails in gases or fine bubbles ; for these latter materials cannot follow the paths of fine eddy motion encountered when streamline flow is broken up. The bentonite method of observation for the first time permits quantitative measurements of velocity charge and other factors within the field.

In the analysis of fluids, bentonite so modifies the light passing through the stream that coloured bands or 'fringes' show up, connecting points where a particular rate of change in the fluid speed prevails. The analysis is similar to the photoelastic methods of analysis for solid bodies. Use of improved photographic techniques including high speed photography has enabled observations to be carried out for highly turbulent as well as for the semi-stream line flow by this method, while qualitatively it can be used to find out how a moving or even a stationary object of particular size and shape affects the flow. Analysis of fluid flow is important not only in such obvious applications as design of aerofoils, boat hulls, or bridge piers but also in many chemical engineering problems, such as the distribution of fluids in reaction vessels. By polarization analysis, it is even possible to calculate the rate at which heat will be transferred from a solid to a liquid.

The bentonite method has as yet received few applications. But some of the applications have already proved extremely important. One of these is providing graphic demonstrations for training aviators in flight theory. Another diverse application is reported to have served to change the design of fire-boxes in the locomotive of a railroad in a Western country and giving it greater efficiency.

S. K. G.

MODERN ENDEAVOURS OF GROWING SEEDLESS FRUIT

Attempts at growing seedless fruits by artificial means may be traced to the end of the ninteenth century. It is only recently that botanists have partly succeeded in growing them. In view of the importance of growing seedless fruits, a brief account of the process and mechanism involved in their production may be useful. It is well-known that after fertilization the ovule is changed into a seed and the ovum into an embryo. The ovary is caused to grow more and more into a fruit. The maturity of an ovary into a fruit and the change of an ovule into a seed are not one and the same process. The pollen tube in a way gives a kind of stimulation to the ovary which matures up into a fruit ; on the other hand, it enters into the ovule and fertilizes it to grow into a seed. It is known that the pollen tube oozes out hormone after reaching the ovary. This hormone stimulates the ovary and changes it into a fruit. If it can be secured that the pollen tube will ooze out the hormone but will not be able to enter into the body of the ovules in order to fertilize them, seedless fruits can be grown without difficulty. The advent of the pollen tube from the stigma to the interior of the ovule takes time which is definite for particular flowers. In some flowers like cucumber, tomato, etc., seedless fruits have been made to grow by cutting off the style, after a time of shedding of the pollen on the stigma. This proves that just before separation the pollen tube was in such a position where it gave out the hormone to stimulate the ovary to grow into a fruit, but was unable to pass through the micropyle of the ovule and fertilize it.

Few chemicals, *e.g.*, acetic acid, alpha-napthalene, phenyle-acetic acid, etc. also can cause an ovary to grow into a seedless fruit. These chemicals should be applied on the top of the ovary after cutting off the style. These can also be applied as spray, poured under the tree, or introduced in solid state to the trunk of the tree.

Experiments on few plants which naturally give seedless fruits showed that a kind of nutritive product, called Auxin, is already present in ample quantity in the ovaries of the flowers of those plants which causes them to mature up. In other plants where the ovary is deficient in Auxin, it is necessary to supply it from outside, either artificially or by chemical processes. In this way also growth of seedless fruit is possible.

C. R. S.

COLCHICINE TREATMENT OF JUTE

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Introduction

SINCE Blakeslee (1937) made his remarkable discovery, many successful results in inducing polyploidy by colchicine treatment have been recorded. The work has been reviewed by Fyfe (1939) and Dermen (1940), who have also discussed in detail the action and use of colchicine. In India striking results have been obtained on *Capsicum annum* L. (Pal and Ramanujam, 1939 ; 1941) and *Cicer arietinum* L. (Ramanujam and Joshi, 1941). In cotton (Amin, 1940) and sesamum (Richharia and Persai, 1940) also, colchicine treatment seems to have been effective in producing polyploids. But no such work on jute has been reported so far and the present study which was started at the Jute Agricultural Research Laboratories, Dacca in 1940, appears to be the first of its kind.

Material and Methods

Two well-known jute varieties D 154 (*Corchorus capsularis* L) and Chinsurah Green (*C. olitorius* L) were at first selected for study but as the latter did not give encouraging results it was dropped.

In 1940, selected dry seeds of D 154 and Chinsurah Green were immersed in 0·4, 0·6, 0·8 and 1·0 per cent. aqueous colchicine solutions for 6, 12, 24 and 36 hours in each case, the number of treatments for each variety being sixteen. To study the effect of presoaking, a few seeds of D 154 and Chinsurah Green were first soaked in water for 30 hours and then for 12 hours in 1·0 per cent. colchicine solution. The seeds were sown in pots.

In 1942 seeds as well as growing terminal shoots of D 154 were subjected to colchicine treatment as follows :—

Seeds :—1. The seeds were first soaked in water for 18 hours and then in 0·05, 0·1, 0·5 and 1·0 per cent. aqueous colchicine solution for 12 and 24 hours the number of treatments being eight.

2. Eight treatments as in 1, but without any pre-soaking in water.

Growing shoots:—Three applications of 0·05, 0·075, 0·10, 0·15 and 0·20 per cent. aqueous colchicine solution on terminal buds of six weeks old vigorously growing plants.

Observations on vegetative characters such as leaf size and shape, size of flower, pollen and fruit, and size and frequency of stomata were taken for detecting cases of polyploidy. Acetocarmine smears of leaf-tips (Baldwin, 1940) were made at different stages to determine the stomatic number of chromosomes. Sections as well as macerated material were examined to study changes, if any, in the anatomical structure.

Effect of colchicine treatment of seed First Generation

Germination:—Seed treatment with various concentrations of colchicine was found to have a marked effect on germination. Germination was considerably checked especially in the higher concentrations, only a few plants coming out successfully (Table 1). As observed by Pal and Ramanujam (1939; 1941) for Chilli, and Ramanujam and Joshi (1941) for gram, colchicine appeared to have a retarding influence on the growth of germinating seedlings. In the lower concentrations the general swelling of the hypocotyl and the radicle was more prominent than in the heavier concentrations, where growth was more effectively checked.

TABLE I

Percentage of Germination in Colchicine treated Seeds (1942)

Per cent. of colchicine / *Treatment.*	0·05	0·10	0·50	1·0	Control
12 hours with 18 hours presoaking in water	27·5	22·5	...	10	100
24 hours with 18 hours presoaking in water	10	2·5	2·5	7·5	...
12 hours without pre-soaking	22·5	...	17·5	2·5	100
24 hours without pre-soaking	45	42·5	20	15	...

Morphological:—In the preliminary studies carried out in 1940 most of the surviving plants from the treated seeds showed no morphological differences from the controls. Only one D 154 plant obtained from seed treated in 1 per cent. colchicine solution for 12 hours, after 30 hours pre-soaking in water, seemed to have responded to colchicine treatment. Its leaves were rough and rounded as compared with the control and the flowers much bigger. The capsules were about double the normal size (Fig. 1) and contained only three seeds per locule (Patel, 1941).

Of the 18 mature plants obtained from the treated seeds in the 1942 experiment only two a268 and b987 were markedly different in appearance from the control, and showed typical *gigas* characters indicating possible cases of polyploidy. Both were from seeds treated in 0·1 per cent. colchicine for 24 hours without any pre-soaking in water. In these plants the stem and petiole were stouter and better developed and the leaves were very much thicker, coarser and broader than in plants raised from untreated seeds. The guard cells of the stomata were 1·5 to 2 times bigger than in normal leaves and the number of stomata per unit area was about half (Table II).

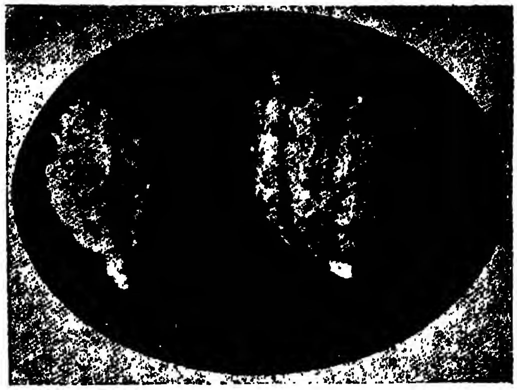

Fig. 1. Capsules from normal (left) and colchicine treated (right) plants (×2¼).

TABLE II

Size and Distribution of Stomata
(*Average of 20 observations*)

Plant	Size of guard cells: Length	Size of guard cells: Width	Frequency (*Number of stomata per unit area**)
Normal ..	24·15μ	6·68μ	12·75
a268 ..	42·15μ	10·95μ	5·7
b987 ..	39·45μ	10·22μ	6·2

* Unit are = ·08 sq. mm.

The flowers too were much bigger, and the pollen grains averaged 45·08μ in diameter in a268 as compared to 29·81μ in normal flowers. Plant b987 which resembled a268 in almost every respect did not show any appreciable difference in the size of

the pollen from the normal, the average diameter being $31{\cdot}77\mu$.

The capsules in both a268 and b987 were strikingly different in appearance from the normal ones. They were about 1·5 to 2 times the normal size with a thick and fleshy pericarp. The outer surface was comparatively smooth without any sharp protruberances as in normal ones and the capsules contained only a few good seeds.

Cytology:—As the morphological characters of a268 and b987 indicated polyploidy due to colchicine treatment, a cytological examination of these two plants was undertaken. Acetocarmine smears of young leaf-tips from these plants as well as controls were made at regular intervals from 9-30 A.M. to 1 P.M. Preparations made from 10-30 to 11 A.M. showed all the stages of mitosis. The diploid number in the normal plants of D 154 (*C. capsularis*) was 14, the same as reported by Banerji (1932). Chromosome counts from a268 and b987 showed that a doubling of chromosomes had occurred as a result of colchicine treatment. Associated with this doubling of chromosomes there was a marked increase in cell size. The cytological examination thus revealed that both a268, and b987, obtained from D 154 seeds treated in 0·1 per cent. colchicine were tetraploids having $4n = 28$ chromosomes.

Acetocarmine smears of dividing pollen mother cells were tried without much success.

Anatomy:—To find out structural changes associated with colchicine induced polyploidy anatomical

FIGS. 2, 3. Ultimate fibres from diploid (left) and tetraploid (right) plants (×220)

examination of diploids and tetraploids was carried out. Transverse sections of both petiole and stem were examined and it was observed that the larger size and the stouter appearance of these organs in tetraploids, was due to increase in size of the cells rather than to an increase in their number. The number of fibre bundles was the same but the bundles appeared larger, the individual fibres showing a large lumen in cross section. In macerated material, the length of the ultimate fibres in the tetraploids was found to be about the same as in normal plants but the fibre width was more. The lumen was very large—almost twice that in normal plants, but the thickness of the wall remained the same (Figs. 2, 3 and Table III).

TABLE III

FIBRE MEASUREMENTS OF DIPLOID AND TETRAPLOID PLANTS
(*Average of 100 observations*)

Plant	Mean fibre length	Mean fibre width	Mean wall thickness	Lumen
Normal (diploid)	2125μ	$17{\cdot}46\mu$	$6{\cdot}21\mu$	$5{\cdot}04\mu$
Treated (Tetraploid)	2407μ	$26{\cdot}52\mu$	$6{\cdot}10\mu$	$14{\cdot}31\mu$

SECOND GENERATION

Seeds collected from tetraploids showed poor germination. Of the 120 seeds sown in pots according to pod size about half failed to germinate, the number of mature plants obtained being only 10. The morphological and cytological behaviour of these plants was studied and they were found to resemble their parents. The capsules were large, but comparatively few, some of the plants bearing only one or two capsules. Leaf tip smears showed $4n = 28$ chromosomes and anatomical examination revealed the same structure as in the parent tetraploids.

COLCHICINE TREATMENT OF GROWING SHOOTS

Treatment of growing shoots with various concentrations of aqueous colchicine did not prove successful in inducing polyploidy. In some cases, especially with stronger treatments the terminal shoot withered and died. There was no appreciable difference excepting for the distortion of a few leaves and flowers in some of the plants. Plumule treatment of germinating seedlings has been recently taken on hand and it is interesting that in some cases differences in the size and distribution of the stomata have been observed.

SUMMARY AND CONCLUSIONS

Seed treatment of jute with various concentrations of colchicine seeds to be effective in artificially inducing polyploidy. Two tetraploids were obtained from seeds treated in 0·1 per cent. colchicine for 24 hours, without any pre-soaking. They showed the typical *gigas* characters, and were also structurally different from the diploids. The fact that

differences in the structure of the ultimate fibre are associated with changes in chromosomes, is of great economic importance, for the quality of jute depends primarily upon the nature of the ultimate fibres.

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MEDICINE AND PUBLIC HEALTH

THE ROCKEFELLER FOUNDATION'S WORK IN 1943

The report of work of the Rockefeller Foundation in the year 1943 makes interesting reading. The income of the Foundation from investments during the year was $8,079,164 and the expenditure amounted to $7,760,186. The different items of expenditure were as follows:—public health, $2,450,000; medical sciences, $1,520,000; natural sciences, $509,000; social sciences, $1,068,000; humanities, $1,055,000; and programme in China, $108,000. Of the above expenditure, 69 per cent was for work in the United States and 31 per cent for work in other countries.

The Foundation took justifiable pride in helping financially the development of penicillin in England, by placing funds and facilities at the disposal of Prof. Florey and other workers. The Foundation lent its support to the Harvard Medical School for the organization of a laboratory of physics and chemistry. Its Plasma Research Section has now undertaken to produce dry plasma for civilian and military casualties during the war.

In Europe, work was financed in Sweden at the University of Upsala and at the University of Stockholm in chemical physiology, embryology, bio-chemistry, bio-physics, neuro-physiology, radiology, etc.; in Switzerland, at the Universities of Basle and Zurich for research in bio-chemistry, organic chemistry and plant physiology. In Great Britain, grants were given to the Universities of Oxford, Cambridge, Sheffield, Edinburgh and Birmingham for basic research in bio-chemistry, biophysics, genetics, organic chemistry, psychiatry, neurology and neuro-surgery. Researches have also been made for work on the Social Sciences by the Royal Institute of International Affairs, the London School of Economicas and Political Scierices, the National Institute of Economic and Social Research in London, the Social Studies Research Committee at Oxford anc Political and Economic Planning (P.E.P.).

The information that the dangerous malaria-carrying *anepheles gambiae* mosquito, whose home is in Africa, has reappeared in Brazil is upsetting. Efforts are, however, bei g made to control the sources of infestation. Another noteworthy fact is the reopening of the Yellow Fever Laboratory at Lagos, which was started in 1925 and abandoned in 1934, in order to study whether the jungle variety discovered in South America has its counterpart in West Africa and to conduct studies in case of positive findings. It is interesting to note that all the yellow fever vaccine which has been manufactured since 1937 comes from a South African native named Asibi who was sick with yellow fever. Studies are also being conducted on typhus. It is realized by the Foundation that science and learning are truly international and that public health can no longer be thought of exclusively in national terms.

A good deal of attention was devoted to the study of the social sciences and the protection of cultural heritage in countries overrun by the enemy during the present world conflict.

NEW TECHNIQUES FOR STERILIZATION

According to *Science News Letter*, April 8, 1944, two new methods of sterilization, one of them for liquids, the other for air in rooms, have recently been patented.

The first is by a well-known scientist, Prof. Alexander Goetz of the California Institute of Technology, who has been awarded patent 2,344,548. It is an improvement on the method of sterilizing liquids by exposing them to certain metals, notably silver, through which slight electric currents are

passed to induce them to release their charged atoms, or ions, into the liquid.

A difficulty with this method has been that the metal surfaces tend to become coated, slowing down their action. Prof. Goetz solves this problem by running an endless chain surfaced with the metal, first through the liquid to be sterilized, then through de-coating and cleansing baths, then through the liquid again. Rights in the patent are assigned to the Sunshine Mining Company of Yakima, Wash.

The second sterilizing method is the joint invention of S. C. Coey and J. W. Spiselman of Middlesex Borough, N. J., who have assigned rights in their patent, No. 2,344,536, to the Research Corporation. It consists of an apparatus to make practicable and economical the recent discovery that the compound known as triethylene glycol is an efficient means of ridding air of germs without rendering it disagreeable or toxic. The chemical is mixed with a small portion of the air at a moderately elevated temperature. This is then diluted into the main stream of the air passing into the room through the ventilating or conditioning ducts.

THE TOTAL SYNTHESIS OF QUININE

In the May issue of the *Journal of the American Chemical Society*, (66, 849, 1944), Woodward and Doering have described an outline of the method for the synthesis of quinine. This work was undertaken as a research project of Polaroid Corporation by the senior author, instructor in Chemistry at Harvard University and chemical consultant to Polaroid Corporation.

The total synthesis of quinine is a great achievement in view of the fact that all the previous attempts have been fruitless. Woodward and Doering have started with 7-hydroxy-*iso*quinoline, a coal-tar product, and have succeeded, through a large number of stages, in preparing *d*-quinotoxine which was converted into quinine by Rabe over twenty-five years ago. This total synthesis of quinine opens up vast possibilities and in future we might get in the market the synthetic quinine to fight out the scourge of malaria.

D. C.

ON Rh CONSTITUENT OF HUMAN BLOOD*

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What Rh is

By Rh constituent is meant that antigenic component of human rbc which is in common with the rbc of the common brown monkey of India (Macacus rhesus). It was first demonstrated by Landsteiner and Wiener in 1941 and named Rh after the name of the monkey Rhesus.

It is said to be antigenic because it has all the properties of an antigen, *e.g.*, (*i*) power of producing antibody when suitably introduced into laboratory animals, such as guineapig, rabbit or fowl, (*ii*) react with the antibody produced in man or animal in the form of agglutination and lysis and (*iii*) being a constituent of rbc is a protein chemically. Rh substance is sometimes called a factor, but there is no need to call it so, because physically substance is the better name, immunologically it should be called an antigen and genetically a character.

* Read at the Society of Biochemistry and Experimental Medicine, Calcutta.

Landsteiner and Wiener in 1941 first showed that the property is present in 85 per cent of white American population and absent in 15 per cent, but they were not sure whether the absence is absolute or relative. Levine in 1942 confirmed the percentage of distribution. Boorman, Wood and Mollison in 1942 showed that the results (positive or negative) may be made sharper by absorbing the diluted testing sera with negative rbc and thereby suggesting an absolute absence. Gollaghar and Jones in 1943 adjusted the dilution of testing sera in such a way as to confirm the above percentage.

The writer has found in 1943 the Rh positive rate amongst the Indians to be 90 per cent and negative rate 10 per cent (Greval and Roy Chowdhury, 1943).

Wiener and Sonn in 1943 showed variants of Rh positivity. The writer has seen that Rh positive animal sera differs from one type of animal to another (*e.g.* Guineapig to Rabbits) as regards the reaction with the positive cells. The reaction with

guineapig Rh prepared showed a gradation from the strongest to the weakest, the possible reason of which is to be found in genetics. All these go to show the complex nature of Rh.

Comparison with Antigenic Constituent of Rh

Other accepted antigenic constituents of human rbc are A and B, M and N. Antigens A and B give rise to 4 different blood groups by their presence either singly or together and by their complete absence. Corresponding antibodies are normally present in human bloods.

Other accepted antigenic constituents of human rbc are A and B, M and N. Antigens A and B give rise to 4 different blood groups by their presence either singly or together and by their complete absence. Corresponding antibodies are normally present in human bloods.

Antigen	.. O	A	B	AB
Antibody	.. ab	b	a	o

Antigens M and N give rise to 3 different types according as they are present singly or together. Both of them can never be absent. Antibodies are not normally present but may give rise to immune iso-antibodies.

Antigen Rh can give rise to two different types according as it is present or absent. As regards the positive there seem to have different variants of it, which can be proved both by the positive human and artificially produced animal sera. Like M and N substances it may give rise to immune iso-antibodies. Inheritance, like group specific substances, is, according to the Mendelian line, the presence being dominant to its absence.

The Rh antigen defied all attempts, to find any relationship with known antigens of blood groups (O, A and B) and types (M and N). Complete serological formula of a blood should represent all these antigenic systems, *e.g.* O, A, B, M, N ; and Rh.

Laboratory Preparations

Guineapigs and rabbits were injected intervenously and chickens intermuscularly with 1 c.c. washed 50 per cent monkey rbc thrice at an interval of 4 days and serum collected 10 days after the last injection. Higher titre was obtained with 3 injections in place of two as recommended by American workers. Guineapigs so far gave better results than rabbits. Chickens with intermuscular injections gave disappointing results. The highest titre found by this method was 1 in 300, lytic titre keeping space with the agglutinating titre.

Lately the writer has used stroma only (after the cells are lysed with distilled water) instead of cells as a whole for injection. It has the advantage of giving intervenously in chickens without the risk of haemolytic reaction occurring. Guineapigs and rabbits were not yet tried. Chickens by this method gave the highest agglutinating titre so far available, *i.e.* 1 in 1000 which is really astonishing where as the lytic titre was very low. The very high protein content of chicken serum probably made it possible. Incidentally it also proves that Rh property like other agglutinating properties (group specific) resides into the stroma and not in haemoglobin.

Mechanism of Anti-Rh formation in Human Subjects

This is due to the effect of inheritance. An Rh − mother mated with an Rh + father may beget a foetus who may have inherited the Rh character from the father.

Now the Rh + rbc of the foetus somehow gaining entrance into the mother's circulation, the rbc of which is Rh − acts as an injected blood into the mother and iso-immunizes the mother.

The immune iso-antibodies thus produced being in solution in serum gain entrance into foetal circulation. Thus incompatible reactions are produced in the foetal circulation producing Erythroblastric anaemia in the foetus called Foetal Erythroblastosis. Further transfusion with otherwise compatible but Rh + blood will necessarily aggravate the condition.

There are, however, some contradictions. For instance, (1) how can foetal rbc enter into maternal circulation and (2) is iso-immunization possible? These contradictions have received explanation which may be referred to as follows:—

(1) According to the accepted view substances dissolved in blood (not rbc) can only pass through the membrane separating the foetal and maternal circulation. But the membrane may, at times, leak and this is perhaps the reason why mishap occurs usually in subsequent pregnancies.

(2) It was found that the serum of patients who had shown haemolytic reactions (*i.e.* incompatible reactions) after receiving repeated blood transfusions of otherwise compatible group bloods contained anti-Rh agglutinin while in the rbc the corresponding Rh agglutinogen was wanting. This showed that the Rh antigen can produce immune-iso-antibodies in human beings. M and N antigens have been found to behave similarly.

Iso-immunization of the Mother by the Foetal Antigen

Iso-immunization of the mother by the foetal rbc antigens was found to occur only when the antigen in question is Rh and not blood group specific antigens (O, A and B) or blood type specific

antigens (M and N). As for blood group iso-immunization is not possible because the corresponding antibodies are normally present in the blood and probably because the group specific antigens are distributed throughout the tissues and fluids of the body and not confined to rbc only and so the corresponding maternal antibodies become specifically bound to the tissue cells and inhibited by the body fluids, so that group specific antigens of foetal rbc are protected. Rh antigen, on the other hand, occurs in rbc alone and consequently is exposed to the full action of the mothers anti-Rh agglutinins that have gained entrance into the foetal circulation. Iso-immunization of the mother by the antigens M and N in foetus does not occur though they have got limited distribution (in rbc only) like Rh substance for reasons not known to us.

Experimental Medicine—Practical Importance in Transfusion

Rh substance is a good antigen in Rh - individuals.

(1) *Re-transfusions.*—An Rh—subject received an otherwise compatible but Rh+ blood in previous transfusion. He develops an anti-Rh aglutinin. Before it is sufficient time for the disappearance of the antibody he receives another transfusion of Rh+ blood. The new Rh+ rbc will be agglutinated by the anti-Rh agglutinin and will cause haemolytic reaction.

(2) *Obstetrical cases.*—Even in the very first transfusion in subsequent pregnancies or in and after labour, an Rh− mother already iso-immunized by foetal Rh+ rbc may develop haemolytic crisis if she is transfused with an Rh+ but otherwise compatible blood. This is the reason why transfusion in some obstetrical cases with severe anaemia worsens the cases. Abortion also comes under this heading. The antibody in mother's blood was found to be present for a period of 2 years after labour in some cases.

(3) *Infant with Foetal Erythroblastosis.*—This is better named as a condition of haemolytic anaemia of the foetus and new born with either hydrops or ichterus gravis. It is usually found in subsequent pregnancies and the mother also suffers from anaemia. The foetus inheriting the Rh+ property from his father when conceived by an Rh− mother iso-immunises the mother and thereby receives from the mother anti-Rh agglutinins which in turn causes haemolytic reaction. Here again transfusion with an Rh+ blood only causes to aggravate the condition.

Such difficulties can be reduced to a minimum by having regard to the following:

(1) To test routinely in all obstetrical (including abortion) and re-transfusion cases, for the presence or absence of Rh substance and select the donor accordingly, *i.e.*, selection of Rh− donors for Rh− patients. For this purpose it is essential to have a constant supply of anti-Rh human serum from iso-immunised Rh− mothers.

(2) To obesrve the direct cross-matching test most scrupulously and lengthen the time limit from half an hour to one hour.

Genetics.—The character Rh is transmitted by means of a pair of genes, Rh and rh and the dominant gene Rh determines its presence (Landsteiner and Wiener, 1943).

So genotype RhRh (Homozygous father) corresponding to phenotype Rh+ must beget Rh+ children. Genotype Rhrh (Heterozygous father) corresponding to phenotype rh , be beget both Rh+ and Rh− children. Genotype Rhrh (Homozygous father) corresponding to phenotype Rh − must beget Rh− children.

Importance in Genetics, Sociology, Forensic Medicine and Anthropology

Sociology.—As Rh− women when mated with Rh+ husbands run the risk of being iso-immunised Rh compatibility before marriage may be rightly demanded by both the parties concerned but as the Rh negative rate is very small actual incidence of such couples (Rh+ X Rh−) is only 90×10=9 per cent Indians and 85×15=13 per cent Europeans of all random matings. ....

Forensic Medicine.—Exclusion of paternity will only be possible in Rh− couples (Rh X Rh−) alleged to have given birth to Rh+ child, *i.e.* 15×15=2, 25 per cent.

Anthropology.—Relationship between the races ot humanity can be shown by the presence of identical antigenic substances.

Some Suggestions for Further Research

This iso-immunization of mothers by foetal antigenic substances opens up the question whether or not other unknown blood constituents can play an important role in several conditions, such as unexplained anaemias of pregnancies in the tropics, stillbirths, congenital malformations, etc.

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BOOK REVIEWS

A Handbook for the Identification of Insects of Medical Importance—By John Smart with chapters on Fleas by Dr Karl Jordan and on Arachnids by R. J. Whittick. British Museum of Natural History, 1943. 269 pages, 13 full page plates and 177 text figures. Price fifteen shillings.

This book represents the first serious attempt that has been made to consolidate into one volume a taxonomic guide to the insects of medical importance throughout the Old World. Dr Smart is one of the ablest students of Diptera taxonomy and has presented the subject in a very masterful manner in this book. Such a work has been badly needed for a long time as the literature pertaining to this subject is widely scattered and not readily obainable. To have this important information in one publication is of special significance during this time of war, since so much of the fighting must be done in tropical climates and it is essential that every possible effort be made to protect our troops from diseases. The great importance of insect taxonomy is soon realized by everyone who has intimate contact with problems in control of insect-borne diseases, especially in instances where specific control is essential. It is impossible to attack any problem scientifically until one knows the species with which he is dealing. An accurate specific determination often gives the key to the erradication of the vector concerned and saves much time and expenditures. This book will be extremely valuable to Army personnel who are working with insect-borne diseases. It provides them with a consolidation of information on the classification of the medically important insects which would otherwise be unavailable to the workers in the field.

The introduction deals with the structure of insects, development and life history, classification and nomenclature and zoogeography. This provides the general background information that is essential to the study of taxonomy so that the text would be entirely usable by any one with enough training in science to understand the system of animal classification and the working of a key. The discussion of classification and nomenclature is very well written. This is one of the best, concise presentations of this subject known to this reviewer. It briefly but clearly outlines the methods and procedures in nomenclature and emphasizes the importance of accurate identification of insect species. The discussion on zoogeography presents a useful table of the faunistic regions and subregions of the world.

The larger portion of the book, one hundred and seventy three pages, is devoted to the Diptera. For the most part all of the medically important families are well handled. The section on structure and life histories gives a review of the important taxonomic characters and a few statements on the developmental stages. The classification of the suborders of Diptera and the keys to the families which are of medical importance is complete and simple to use. The excellent illustrations of the Diptera, as well as the other Arthropoda, clarify the keys and other subject matter.

The psychodidae are the first flies that are taken up. The discussion is very brief and inadequate. In view of the importance of these flies in most sections of the tropics it seems that a key to the Phlebotomus should have been included. Even though the species determination of Phlebotomus is a matter for the specialist, it so happens that there are many capable Dipterists working in the field who do not have access to the necessary literature.

The other families are discussed under their respective suborders and keys are given to the medically important genera. A few short statements are given on each of the more insignificant families and no keys are felt necessary. The family Muscidae is thoroughly treated, with generic keys, notes on the important genera and keys to the species of Glossina. The Calliphoridae (the Sarcophagidae of most Dipterists are included in this family) are keyed to genera and notes are given on the important ones. The Oestrides and Hippoboscidae are adequately treated although no keys are provided.

Ten pages are devoted to a comprehensive treatment of the subject of myiasis and the identification of myiasis-producing larvae. This appears to be very thorough and well worked out ; it should be very useful to the medical entomologist.

The phylogenetic order is somewhat upset when the Culicidae are left out of the discussion on the Nematocera and are taken up by themselves directly after the Cyclorrhapha. Ninetynine pages are given to this all important family and this section is perhaps the most useful portion of the entire book. Keys to the subfamilies, tribes and genera of the Culicini, adults and larvae, and to the species of Anopheles are given. The latter are divided into

keys for the Palearctic region, the Ethiopian, the Oriental and the Australian region and deal with adults and larvae. The keys have been compiled from many sources but have been brought up to date and simplified in many places. The section is very excellent and is made even more valuable by the inclusion of a table on the breeding places of Anophelines, a list of the synonyms and important misidentifications: also a list of the malaria-carrying species given under countries and a very good treatise on distribution and literature pertaining to the Anophelini.

The other insects of medical importance are dealt with in thirty two pages, with twenty one of these being devoted to an excellent discussion by Dr Jordan on the Siphonaptera. The orders Orthoptera, Anoplura, Hemiptera, Lepidoptera and Coleoptera are briefly considered. Dr Jordan's section is exceptionally well done and will be of much value to workers in Flea-borne diseases. After an introduction to the group, giving the medical importance, biology and notes on taxonomy, he has keys to the important genera, notes on the genera and a key to the species of the genus Xenopsylla. This section is very well illustrated and most of the figures are original.

The remaining Arthropoda are treated by R. J. Whittick of the Department of Zoology at the British Museum. Under the Scorpions he gives the structural characters of only the Buthidae and Scorpionidae and leaves out the other four, less common, genera. The Araneae and Acarina are discussed briefly but keys are given only to the families and genera of the Ixodoidea. The medically important genera and species are treated adequately. The last few pages of this section are given to short statements on the Pentastomida, Myriapoda and the Crustacea.

An eight page appendix presents very useful notes on methods for collecting and preserving insects. It discusses the materials and equipment needed, tells how to prepare killing bottles, aspirators, etc. It gives the various methods of preserving and preparing insects for study and the various formulae for preserving and mounting. Some of the more pertinent literature on insect collecting and sources of entomological supplies are given at the end of this chapter.

In conclusion the reviewer feels that this book is a very outstanding contribution to the war effort and that it will be especially useful to entomologists and medical men of the Allied Armies. It is clearly written and very beautifully illustrated, the excellent figures demonstrate the subject matter explicitly. The bibliographies at the end of each chapter are well chosen and appear to be fairly complete. It is regrettable that the book confines itself to just the Old World, the inclusion of keys and figures to the Nearctic and Neotropical regions would have increased its value and would have given a world wide coverage of the subject in one volume.

D. N. R.

Experiment and Theory in Physics—By Max Born, Cambridge University Press. Price two shillings net.

The short monograph is an expansion of an address by Prof. Born given to the Durham Philosophical Society and the Pure Science Society in the summer of 1943. He deals with a theme that is very familiar to the physicist and his present address is directed mainly to the man-in-the-street and the philosopher rather than to the physicist. He attacks again the oft-criticised epistemologists specially the abstruse cosmological theories of Eddington and Milne. Prof. Born attempts a dig at the extreme experimentalists of the school of Lenard and Stark and finally settles down to an analysis of the growth of Relativity and Quantum Mechanics. His analyses emphasize the slowly accumulating empirical foundations on which these present elaborate theories rest. He explodes for, perhaps the nth-time the fiction of pure reason and details how the experimental discovery of the neutron could not have been foreseen by any reasonable guess of epistemology. Regarding Eddington he sums up excellently, thus, "I shall not attribute any possible success (of Eddington's Theories) to Eddington's philosophy as a doctrine which could be followed by others, but to his personal genius and *intuition.*" Regarding Milne he is rather obscure except for the usual argument about the obvious problem of age of the universe which Milne puts at $1 \cdot 5 \times 10^9$ years in his cosmology.

On the whole Prof. Born's criticism of current cosmological theories by the epistemologists is a popular and lucid exposition but he hardly says anything new or remarkable to interest astrophysicists and cosmologists.

B. D. N.

LETTERS TO THE EDITOR

[The editors are not responsible for the views expressed in the letters.]

NEW CONTINUOUS EMISSION BANDS IN THE SPECTRUM OF CHLORINE

Apart from those due to temperature radiation, continuous emission bands which can be attributed to diatomic molecules are the simplest of their type. The importance of continuous band spectra for the development of the theory of structure of molecules is clear if one realises that these afford probably the only source of information regarding the repulsive energy states of a molecule. The spectrum of chlorine suitably excited by high frequency discharge is known to possess a large number of such continuous bands an elucidation of which is expected to throw considerable light on the structure of chlorine molecule. Cameron and Elliot[1,2] have recorded a number of bands which we have included in two main groups. Each group is composed of a strong band followed by a few weaker ones on the short wave side. In excitation by active nitrogen, only one band λ 2564, the strongest in the second group is observed which is interspersed by a diffuse-banded structure.[3] On exciting pure flowing chlorine at a pressure of 1 to 2 mm. by a mild high frequency discharge (650 to 700 K. cycles per sec.) a number of additional bands are recorded on our plates (Kodak Process B 5). We have measured them on a large number of plates visually and the data pertaining to all the bands present on our plates are included in the table, where also the data of Cameron and Elliot are given. These comprise in addition to the already known group I and two bands in group II, five new bands in group II and an altogether new group III of bands headed by a band at λ 2001 and followed by two more bands upto the limit of the quartz spectrograph used. It seems very likely that the bands extend into the vacuum region. In agreement with Cameron and Elliot's observation no structure is seen either in the band at λ 2564 or in any other band.

Group No.	Intensity (Visual)	band in A. U.	Position of maxima: Authors λ in air	Position of maxima: Authors ν Vac.	Position of maxima: Cameron & Elliot λ in air
I	8	3160-2983	3063	32863	3063
	3	2983-2923	2954	33843	2957
	4	2923-2852	2880	34712	2881
	3	2852-2793	2818	35488	2819
	1	2793-2737	2759	36234	2758
	1	2737-2675	2718	36781	2714
II	10	2675-2473	2564	38990	2564
	8	2473-2380	2428	41174	—
	6	2380-2318	2349*	42558	—
	4	2318-2250	2287*	43712	—
	2	2250-2163	2200*	45440	—
	1	2163-2105	2139*	46736	—
	0	2105-2055	2076*	43154	—
III	2	2055-1955	2001*	49959	—
	1	1955-1892	1918*	52120	—
	0	†—	†1865*	53890	—

* New bands.

† Uncertain, confused with the intense Schumann-Runge Oxygen Absorption bands at λλ 1883, 1864.

We are very grateful to Dr R. K. Asundi for his valuable suggestions and guidance during the course of the work.

NAND LAL SINGH
K. SRINIWASA ADIGA

College of Science,
Benares Hindu University,
Benares, 21-6-1944.

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BALANCING OF CHEMICAL EQUATIONS

Students of Chemistry often find the numerical balancing of chemical equations ticklish. I devised a method for balancing them as far back as 1933 and as uptil now I have not come across a like method either in books, or in the lecture-room or outside. There is nothing fundamentally new about it. It only puts algebraically the fundamental concept of indestructibility of matter and solves the equations infallibly and surely.

As an example, let us balance the well-known equation :—

$$H_2SO_4 + KMnO_4 - K_2SO_4 + MnSO_4 + H_2O + O$$

We put the equation like the following, introducing unknown coefficients x, y, z etc.

$$xH_2SO_4 + yKMnO_4 = zK_2SO_4 + sMnSO_4 + tH_2O + O$$

The coefficient of one of the members of the equation *i.e.*, O, has been taken unity.

We now equate the numbers of atoms of each element, occurring on each side of the equation.

From H atoms:—

$$2x = 2t \qquad \ldots\ldots\ldots\ldots (1)$$

From S atoms:—

$$x = z + s \qquad \ldots\ldots\ldots\ldots (2)$$

From O atoms:—

$$4x + 4y = 4z + 4s + t + 1 \qquad \ldots\ldots (3)$$

From K atoms:—

$$y = 2z \qquad \ldots\ldots\ldots\ldots (4)$$

From Mn atoms:—

$$y = s \qquad \ldots\ldots\ldots\ldots (5)$$

We solve the above five equations simultaneously.

From (1) and (2)

$x = t = z + s$

From (4) and (5) and above.

$$y = s = 2z = \frac{2x}{3} = \frac{2t}{3} \qquad \ldots\ldots (6)$$

We put the above results in (3), in terms of one unknown say, x.

We get $4x + \frac{8x}{3} = \frac{4x}{3} + \frac{8x}{3} + x + 1$ or $x = \frac{3}{5}$

and therefore $t = \frac{3}{5}, y = \frac{2}{5}, s = \frac{2}{5}, z = \frac{1}{5}$

Hence we write the equation as

$$\tfrac{3}{5}\,H_2SO_4 + \tfrac{2}{5}\,KMnO_4 = \tfrac{1}{5}\,K_2SO_4 + \tfrac{2}{5}\,MnSO_4 + \tfrac{3}{5}\,H_2O + O$$

Which becomes

$$3H_2SO_4 + 2KMnO_4 = K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$$

The method becomes simpler and more brief by practice. For example, one could have written at the very outset y instead of s for $MnSO_4$ in the chemical equation because there are no other atoms of Mn except in $KMnO_4$ and $MnSO_4$.

The method has indirect uses also. If some molecules were placed on the wrong side, the value of its coefficient would come out negative. Also if an equation is mathematically impossible, it is also chemically impossible.

R. PARSHAD

Irrigation Research Institute,
Lahore, 5-7-1944.

CANNIBALISM AMONG FRESH WATER FISH

Cannibalism or feeding on its own species is a frequent occurrence among carnivorous fish, such as, *Koi* (*Anabas testudineus*), *Singhee* (*Heteropneustes fossilis*), *Magur* (*Clarias batrachus*), *Chitol* (*Notopterus chitala*), *Boal* (*Wallagonian artu*), etc. This sort of cannibalistic habit is not only restricted amongst adults but can be found at all stages—fry, adolescent and adult. Cannibalism aggravates with the scarcity of food and space.

It may be difficult to believe that herbivorous fish like, *Labeo rohita, Labeo calbasu, Cirrhina mrigala, Catla catla, i.e.*, all the major carps of India, and all other smaller types have this cannibalistic habit, yet the fact remains the same. The only difference being with the carnivorous type is that such habit is restricted at a particular fry stage which we generally do not perceive due to our lack of observation.

During our investigation with the scheme of the life-history, bionomics, and development of fresh-water fish of Bengal, financed by the Imperial Council of Agricultural Research, we have frequently observed that there are four definite stages regarding food-habit of major carps. The first stage should be the hatched fry which begins to take food after its mouth opens till it attains a size of 10 mm. Soon after the mouth develops these fry begin to take unicellular algae and not any protozoon, as paramoecium even is too big for them. This stage may be called as true herbivorous condition. From 10 mm. to 20 mm. the major carps take mostly animal bodies, such as protozoon, small crustacea and almost negligible proportion of algae. Such a stage may be called a carnivorous condition. This stage is followed by a stage which can be said as omnivorous condition as they take vegetable and animal food half and half. The duration of this stage is restricted from 20 mm. to 250 mm. Finally there is the stage which may be called as the second herbivorous condition which includes even the adult form. It should be mentioned that *Catla catla* is an exception as they continue the omnivorous condition from 3rd to the adult stage.

During carnivorous stage of carps cannibalism is frequently seen. Stronger ones devour the weaker ones either partly or wholly, although people have an idea that herbivorous fish is free from such a pernicious habit and such habit is only restricted to carnivorous types. It has already been pointed out that there is no true carnivorous or true herbivorous fish.[1] Strictly speaking every fish is omnivorous. We classify fish as carnivorous or herbivorous only from its major proportion of food.

Cannibalism is one of the nature's means of restriction of over population. Mortality due to this is not so much as the mortality at the time of hatching. This is due to sudden change of environment from egg-capsule to water in which the eggs are lodged that causes the greatest mortality in the life-history of any fresh-water fish.

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Calcutta University,
Calcutta, 7-7-1944.

[1] Mookerjee, H. K., SCIENCE AND CULTURE, 9, 306, 1944.

SCIENCE AND CULTURE

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MEDICAL EDUCATION IN INDIA

EDUCATION always presupposes an ideal and a purpose. Medical education is a specialized continuation of general education but with a definite purpose. Medical education cannot therefore be considered entirely apart from general education, as its efficiency is connected with the quality and quantity of the general, and preliminary education which a student receives, before taking up the medical course.

MEDICAL EDUCATION THROUGH AGES

The nature of the educational course has varied with the ages. In various epochs of history, the doctor has been a magic man, priest, craftsman, cleric, and in Europe in the Middle Ages, he was a pedant swearing by Hippocrates, and Galen, as in India today the indigenous medical man still swears by Charaka and Susruta. It is only with the rise of natural sciences, and after Paracelsus, Vesalius and Harvey that the medical man became a scientist. As the universities came into existence, medical education became a part of the university framework. In the process of evolution, didactic teaching was supplemented and ultimately replaced by demonstrations, practical work in the laboratory and field, and with organized investigations of the various problems confronting the cure and prevention of diseases. The evolutionary process is still in progress. The important discoveries made during the past 60 years in the basic sciences of physics, chemistry and biology have been placing in the hands of the medical man newer tools to control the incidence of diseases and to alleviate human suffering.

While medical education is thus becoming increasingly complex, and difficult to deal with, the purposive element of education is undergoing a gradual, but radical change. The Industrial Revolution which started in the 18th century transformed the complex of society in many countries, giving rise to large urban areas based on industries, where large rural population poured in and underwent a rapid, but invariably painful process of urbanization. This not only gave rise to novel problems in public health, but opened up before the medical man large fields for practice and experimentation, but above all, a far wider scope for raising his income, which he fully utilized, taking advantage of his high and complex training in sciences. Treatment in most cases became so expensive that only the rich could afford it, while the poor man had to be left to his fate.

It is only recently that there has been a general protest against this state of affairs, and the prevention of disease and maintenance of physiological hygiene for the general mass of population, and concurrently a strong demand for social security in health matters for the community have loomed up before governments. The doctor has also to realize that he should not regard himself as a mere therapist. The public has realized that though the present day doctor may be in possession of sufficient scientific means to practise curative medicine on a large scale, the ideal should be prevention of diseases, the chief cause of which is poverty with all its dire consequences—ignorance, slums, malnutrition, prostitution etc. For a solution of the cognate problems, medicine needs to be a social science and what is needed to-day is that we produce not only a scientific physician well-trained in laboratory, clinic and field work, but a social physician who is conscious of the scientific developments, the social functions of medicine and the social maladjustments which give rise to disease. Sir George Newman has said,

"the ideal of medicine is the prevention of disease, and the necessity for curative treatment is a tacit admission of its failure."

As a result of this conception the barriers between preventive and curative medicine have been

gradually breaking down during the last 30 years or so, and the medical curriculum is gradually undergoing a change. The student is being taught not only to become interested in disease but also in health. He is being taught that every case should be analyzed medically and socially as to the factors which have made it possible to produce the diseases, and as to what measures could be taken to prevent similar cases in the future. The student must be made familiar with the problems, working and living conditions of the different income groups of the population. It is being impressed upon him that medicine is not a competitive business but a service and that there is no direct relation between their work and their income. The idea of State Medicine is gaining ground, aiming to provide the physician with a decent, though modest, living on similar lines to that of other public services. Thus the objective of medical education has changed, necessitating a new curriculum adapted to the present and future needs of the society. The purpose of the curriculum should be to guide the student and to help him to develop his personality and a correct attitude towards the problems of health and to acquire knowledge and skill in the technology and sociology of medicine.

An inquiry into the curriculum and methods of training in medical education was carried out in more than one country during the early years of the present century. As a result of these inquiries certain principles have been established, the more important among them being as follows:—

(1) That a definite minimum standard of education must precede admission to a medical school or college and that this should include physics, chemistry and biology for at least 2 years. A certain number of hours should also be devoted to the history of science and introduction to medicine, languages and literature, mathematics, anthropology, sociology and economics. In order to make this pre-medical education effective, the secondary education which the student has received must be of the proper standard, as the difference between secondary and university education is as the difference between immaturity and maturity. It is widely agreed that the teaching of basic sciences should begin at school and that, in the university course of general science, stress should be laid upon physical chemistry and organic chemistry and that in the biology course more stress should be laid on such biological principles as the theory of evolution, adaptation to environment and genetics and less time should be given to memorizing of details of animal types. In choosing a student for the medical career, his or her academic record, intelligence, character and personality should be taken into account.

(2) That the main defects of the existing system of training are (*i*) absence of the university ideal, (*ii*) subordination of teaching to examination, and (*iii*) waste of energy in hospital schools.

Until recently the universities had confined themselves to prescribing a curriculum and in conducting examinations on a syllabus. The educational ideal fell short of broad educational objectives which required that the basic training should include the acquisition of knowledge of the fundamentals of the medical sciences, the acquiring and understanding of certain indispensable techniques, the development of initiative, of a scientific point of view, and of proper methods of work. The intention of medical teaching institutions was not to make its students experts in all the subjects but rather to have a sound foundation for future development. The education of a physician is never completed and it has to be continued throughout his professional life. Medical education is directed towards two objectives—educational and vocational. In the former, the student is taught method so that he can collect, analyze and interpret facts for himself and observe and understand what he observes. In the latter, he is given such knowledge adapted to the requirements of the country as will enable him to ably practise medicine on his own account. In preference to the emphasis on factual knowledge, the student should be grounded in methods and principles which he can apply to the requirements of the situation. The methods of examination of students have, therefore, to be adapted to the changing objectives and curriculum.

(3) The functions of a medical teaching institution are to provide stimulus, guidance, supervision and facilities essential to its students in the acquisition of education. Contact with active research programmes or, better, actual participation in such programmes, are factors of major influence in the educational development of the student. Satisfactory stimulation and leadership is impossible in the absence of a competent, interested and active faculty.

(4) It is necessary for an institution of the modern type to address itself wholeheartedly to the advancement of knowledge, the study of problems, and the training of men at the highest level of efficiency. It is desirable that it should be affiliated with or integrated in an university, where the pursuit of science and scholarship is the ideal, even if it means some sacrifice of independence.

In an university atmosphere the students have an opportunity to work in constant association with fellow-students of their own and other faculties, where knowledge is pursued not only for the sake of information but for the attainment of truth, with the further advantage of a close association of undergraduate and post-graduate work. Integration of medical colleges in an university offers opportunities for broadening the objectives and procedures of medical education by the influence derived from wider association and the extension of the influence of medical education into many spheres of university activity. The university faculties should be properly constituted to keep a vigilant eye on the methods of teaching imparted in the medical colleges under them and all appointments should be made by the faculty. The college should be under a Dean who should have the necessary educational and administrative experience in his native country and abroad and should

possess the necessary tact and administrative ability. The university should receive an adequate block grant from the Government to keep the medical college at the required level of efficiency. In addition, it should try to secure decent endowments for expansion and research. As the cost of medical education cannot all be recovered from students' fees, it is best to keep students' fees in medical institutions at par with fees in other lines of university activity and to offer scholarships and studentships as far as funds permit.

(5) That medicine must be learnt neither from books alone nor from lectures alone but chiefly from observation of the sick, whether in the hospital or in the social *milieu*, and that all instruction is to be given by men actively engaged in research in their respective fields.

Medical subjects have an observational and experimental basis which is constantly changing. The student must, therefore, be trained in these methods, not merely lectured to.

(6) The first 2 years of the under-graduate curriculum in a medical college are usually devoted to the pre-clinical or basic sciences with a sprinkling of such knowledge of the human body and the human society as can be assimilated by the student, and the next 2 to 2½ years are devoted to the application of the basic sciences in the various major branches of clinical medicine. An additional half to one year is devoted to internship. This is followed by post-graduate appointments as "house officers", when the graduates receive detailed and specialized knowledge in different fields.

It has been accepted that the former text-book, drill-master courses are to be discontinued and didactic exercises to be reduced to a minimum. These are to be replaced by actual experiences in the laboratories, hospital wards, libraries, conferences, seminars, clinics and field work in the community.

It has been recognized that the student receives satisfactory guidance and supervision only through intimate and competent teacher-student relationship. The ratio between teacher and student for this purpose may vary from 1 : 5 to 1 : 10. The optimum ratio of theoretical to practical training stipulates that for every hour spent on theoretical lecture at least 2 to 3 hours should be alloted to practical instruction, whether in the laboratory, dissection room, bedside, clinic or the field. The pre-clinical course should include among its subjects history of medicine, sociology, bio-chemistry, bio-physics, and bio-statistics. The clinical course should include a training of nursing, nutrition, housing and sanitation, social medicine, industrial hygiene and occupational diseases, pediatrics and psychiatry. The course must be supplemented by clinico-pathological and medico-sociological conferences, and at least two months of field work during every year of the clinical period should be given throughout the clinical course. Teams, consisting of students of medicine, nursing, midwifery etc., shall be sent out with instructors and their work shall consist of surveys in various regions, work in connection with public health agencies, nurseries, clinics, co-operative health associations etc., medical relief in distressed areas and similar tasks. The idea is to give the student a comprehensive view of the health situation and problems of the country both in rural and urban areas. It is expected that the student will thereby learn to identify his interests with those of the people. It is necessary that every medical college should have its own community practice fields. The teaching of preventive medicine should be organized on the same basis as the other major subjects in the clinical period.

(7) Post-graduate education should form an important part of a medical teaching institution and should consist of (*i*) short or refresher courses, lasting a few weeks, on various subjects; (*ii*) courses, lasting for several months, on broader subjects; (*iii*) courses, lasting for one to two years or more, for specialists; and (*iv*) courses for auxiliary personnel.

(9) Every medical teaching institution should be properly equipped with the necessary apparatus and an up-to-date functionating library.

Medical Education in India

Viewed in the perspective given above, let us try to assess *medical education in India*. Some of the medical colleges in India were started one hundred years ago; with the establishment of universities in India in 1857 some of them were affiliated to the universities. The universities laid down the curriculum and conducted the examinations. The colleges were controlled by the Government and teaching was imparted, until lately, by Government officers belonging to the Indian and Provincial services. The appointments were not guided by the requirements of the professorial chairs, and very often teachers were transferred from one chair to the other in total disregard of the needs of education. Most of these institutions being under the medical branch of the Government administration, the universities could not take part in shaping their policy. Despite the fact that all medical colleges in India today are affiliated to one university or other, education in them is not planned according to the true principles of university education, nor does it sufficiently forcefully stress the modern trends in medical and public health education neither does it sufficiently relate to the requirements of the country. It has been laid down in other countries that only men with high academic qualifications, teaching and research experience, experience at foreign universities, originality, initiative, integrity and right outlook should be selected as teachers. There is a complete violation of these principles in the matter of appointing teachers in medical colleges and schools in India. Of late there has been a tendency to make appointments on communal basis to the detriment of academic objectives. Appointments on

communal considerations do not exist anywhere in the world.

There is nothing like a Dean, in the real sense of the word, in most of the medical colleges to manage and shape the policy of education in these institutions. Very few of the Principals have any experience with international trends in education and have made a special study of the subject. The result is that he carries on the day-to-day administration without any sustained effort to improve the quality and content of education.

While England, America and other countries have tried to level up medical education to meet the growing needs of the modern community, medical schools and colleges in India have largely remained medieval. The existence of university grade and lower grade medical schools is an anachronism in modern society. The number of institutions is not related to meet the needs of national health in the country. The institutions are ill-equipped, the curriculum badly planned, teachers inadequately trained, teaching methods old-fashioned and the staff inadequate. Teaching is still chiefly didactic and the social sciences have no place in the curriculum. There is no close correlation between the different stages of medical training—pre-medical, pre-clinical and clinical. The teaching in most subjects is not purposeful and real, and violates Abraham Flexner's dictum that "medicine is learnt; it is not taught." Many subjects which have assumed importance in medical education in various universities are noticeable by their absence in the curriculum in India. Besides, teachers hardly engage themselves in research work and students are usually taught from books written in foreign countries, which do not contain the results of investigations carried out in India.

The medical colleges, with the exception of one, are not integrated in the universities. Except three non-official medical colleges, they are controlled and run by the medical administrative departments of the Government, who rarely possess the necessary training in planning and administering medical education. As far back as 1913, the Royal Commission on University Education in London emphasized the incorporation of medical schools into the universities. But in India, the old system has been going on to the detriment of a sound system of medical education. The levelling up of medical education in India is, therefore, urgently needed.

Most Faculties of Medicine in Indian Universities have a Board of studies, formed from the members of the Faculty, one of whose important functions is to indicate how best the tools of scientific progress could be adapted to the changing needs of the community. It is sad to reflect that, instead of attending to this more important function, it is chiefly concerned with the selection of examiners.

Post-War Planning in Medical Education

It is reported that a post-war committee of the Government of India is now engaged in studying the standards prevailing in India with a view to devising measures for improving them. It is hoped that their labours will bear early fruit. We hope the committee will realize that education is not only for today and that the methods of education that we employ today will help us to plan for the future. A poorly designed and equipped medical college is a bad investment. We should like to draw the attention of those concerned to the warning of Plato who said that "the most gifted minds, when they were ill-educated, became pre-eminently bad." India needs to hurry up if the enormous time lag is to be overtaken.

Suggested Measures of Reform

The first reform that is needed is to abolish or raise the so-called medical schools in the country to the university level, and to level up the university grade medical colleges to modern types. The universities should take entire charge of the medical education through a properly constituted Faculty of Medicine, where teachers should have a predominant voice not only in laying down the curriculum but also in the selection and appointment of the proper type of personnel. If all the medical colleges cannot be raised to the high-ranking university type, at least one college should be so raised in each province or under each university. The Medical Council of India may co-ordinate medical education in the various provinces. The Government should make an adequate grant to the university to improve medical education and to run the colleges at the required level of efficiency. Teaching methods should be thoroughly revised and the proper type of teachers appointed. Less time should be devoted to text-book assignments and more to practice periods under proper supervision. Intimate and competent teacher-student relationship in medical education, which hardly exists here, should be introduced. It should be the aim of the university not only to arrange to train the necessary personnel but also to help in evolving practical methods of solving the various medical and public health problems of the country.

Hitherto the practice in medical teaching institutions has been to run the departments "on the cheap" by employing teachers whose minds and interests are bound elsewhere. So long as the staff is mainly occupied in earning a living in other ways than by teaching and research no real improvement can take place. If the standards of the teachers are poor,

it is bound to react adversely on higher medical thought and education. The higher-ranking institutions referred to above may help in training teachers of the proper standard. It is whispered that there is a proposal for starting such an institution in the capital city of India at an estimated capital expenditure of Rs. 7 crores! Remembering that India needs about 110 university-grade medical colleges to supply the personnel necessary to execute the programme for taking up the lag and that the allocation for public health expenditure may not be unlimited, it should be considered whether a high expenditure like this should be spent in developing a new institution in which a lot of money will have to be sunk in buildings, or whether it should be distributed in raising the standard of several existing provincial institutions. Moreover, one institution in India will not be able to supply all the teachers needed for something like 110 medical colleges. It may so happen that some of these institutions may specialize in certain spheres, thus offering an opportunity of pooling the higher training facilities. No satisfactory improvement can take place unless and until all the senior teaching appointments are made full-time, with adequate emoluments to prevent them from being lured by other sources of income.

Scientific research in the universities, both for its own sake and as a background for scientific education, is the fundamental basis of all scientific progress. The unsatisfactory state of research in the Indian Medical Colleges is due to the absence of academic influence or an university atmosphere. A fair amount of medical research in India has been done at special institutes not connected with medical colleges or universities. This deprives the research workers from the stimulus obtainable from young enquiring minds in an university environment, while it hampers the growth of research centres in teaching institutions. The sooner this anomalous tendency is given up the better.

In the absence of high-ranking medical colleges in India, and in the absence of a good system of post-graduate education and research, many talents which can be brightened by polishing, do not get a chance of improvement. It has been stated that post-graduates in India find it easier to obtain qualifications in foreign countries than to secure them in their own *alma mater*. For this situation, the universities as well as the medical colleges are to blame. In this connection, the criticisms made by a distinguished member of the Indian Medical Service (Lt.-Col. G. R. McRobert) in a recent issue of the *Indian Medical Gazette* (April, 1944) are both timely and justified.

UNDESIRABLE COMPROMISE WITH PSEUDO-SCIENCE

Lastly, one thing requires close consideration by the people of India; it is with regard to the tendency of Provincial Governments and local bodies to set up or support separate teaching institutions for Ayurvedic, Unani and Homeopathic medicine. This is creating complications, which will be difficult to remove as time goes on. The present tendency of Provincial Governments to register practitioners of these separate systems of medicine, most of which lack systematic scientific training, is a move in the wrong direction. Science is progressive and is the same throughout the world; the basic sciences of chemistry, physics, biology, physiology, pharmacology, pathology, and bacteriology are the same all over the world. The criterion of the right of a doctor to medical practice or to the privilege of registration must depend on the basic knowledge he possesses of the fundamental sciences of chemistry, physics, anatomy, physiology, pharmacology, pathology and of medicine, surgery, midwifery and other cognate subjects. All the tools of modern science must be utilized for the early and correct diagnosis of diseases, and unless an accurate diagnosis is made no proper treatment is possible. No system of medicine, Ayurvedic, Unani or any other, can get on without the help of modern basic sciences. There should be no spirit of communalism or opportunism concerning matters of life and death of millions of the population of India. The question of prevention of communicable diseases cannot be successfully solved unless scientific methods of proved efficiency are adopted. The proper move should be to have only one medical science which has been worked out by the scientists all over the world, incorporating into it whatever good there may be in the indigenous medical sciences of the country. It is not our purpose to say that medicines in the other systems of medicine are not efficacious but that they require to be scientifically studied and the best place for doing this would be the university grade medical colleges with their attached hospitals where a separate section may be kept in the Department of Pharmacology and Therapeutics for the study of the indigenous remedies. The students of today will then get an opportunity to know what is best in the indigenous systems and to utilize it in the amelioration of human suffering, instead of the present confused state of affairs. If India is to achieve her place among the first-rank nations of the world, she must advance with the help of modern sciences and she must discourage any retrograde measures which will impede that progress.

JOHN DALTON (1766-1844)

EXACTLY a century ago, on the 27th July, 1844, John Dalton, the founder of the atomic theory, passed away from this world, but left a legacy behind which has enriched the world of science and the entire civilization to an extent that can be said of very few other men. Though one of the greatest scientists of the world he was not less so as a man. For, he was not born with a silver spoon in his mouth ; and it was by means of sheer perseverance, selfless devotion, firm determination, ceaseless labour and untiring struggle against many adverse circumstances that he rose to the high position in life—a position not of wealth, of course, but a far nobler one of benefiting mankind. Though rich in fame he always remained poor in worldly wealth. His habits were extremely simple and unassuming ; he never cared for money and devoted himself unreservedly to the pursuit of knowledge for its own sake. These are the sterling qualities which constitute ingredients of a real man and enable him to stand head and shoulder above his fellow men. This was what Dalton himself said in later life:

> "If I have succeeded better than many who surround me, it has been chiefly—I may say almost solely—from unwearied assiduity; this not so much from any superior genius that one man possesses over another but more from attention to study and perseverance in the objects before them that some men rise to a great eminence than others."

If genius may be defined as 'an infinite capacity for taking pains', then we may call Dalton a genius.

Dalton was born in 1766 in a thatched cottage of a humble family in the village of Eaglesfield in Cumberland. His father Joseph Dalton was a hand-loom weaver. Dalton thus described his own early years—"The writer of this was born at Eaglesfield, near Cockermouth in Cumberland. Attended the village school there and in the neighbourhood till 11 years of age, at which period he had gone through a course of mensuration, surveying, navigation, etc."

Between 11 and 12 years of age he opened a school in his father's barn for children of both sexes. At 15 he left his native village and walked about 40 miles to join his brother's school at Kendal where he worked as a teacher with his brother for 12 years. During this period he was also engaged in self-improvement and self-education. By hard and unremitting toil he became a good mathematician and acquainted himself with the work of Newton, as well as those of other English and Continental men of science. In 1793 he came to Manchester as a teacher in Manchester Academy (Manchester New College) and earned £80/- only for a session of 9 months. For six years he served as a tutor in this college teaching mathematics and natural philosophy. He then resigned and devoted himself to scientific enquiry earning his bread by private tutition which provided him with sufficient means to meet his small needs. He continued with this mode of life till his death in 1844. At the same time he was always meditating and experimenting upon the composition of air and constitution of gases, which led to his discovery of the Law of Thermal Expansion of Gases with which his own name is associated with that of Gay Lussac. He also studied the absorption of gases in liquids and as a result thereof formulated the Law of Partial Pressure, also associated with the name of Henry. To him we owe further the discovery that gases are heated by compression and cooled by expansion against pressure.

In 1800, he became the Secretary of the Manchester Literary and Philosophical Society, of which he was elected President in 1817 and continued as such until his death. He had his laboratory in the house of the Society, and his diary and manuscripts still remain in their possession. The Society also published most of his scientific papers. Dalton's mind was philosophically bent, and, influenced by Newton's views, he believed in the existence of atoms long before his formulation of the Law of Combination in Multiple Proportions. It may be stated that his atomic conception of matter guided him in the discovery of this law and not, as usually believed, that the latter led him to the discovery of the Atomic Theory. The Law of Multiple Proportions resulted from his examination of the composition of marsh gas and ethylene, as well as of oxides of nitrogen. For, he found that when two substances combine they do so in simple multiples of whole numbers. He showed that atomic conception of matter could satisfactorily account for all the physical properties of gases studied by him, as well as the Law of Constant Proportion formulated by Proust and that of Multiple Proportion by him. He thus adduced experimental evidences for the first time in support of the Atomic Theory of Matter. At the end of his great paper "On the Absorption of Gases by Water and other Liquids" which was read before the Manchester Literary and Philosophical Society, Dalton gave an account of his work laying the foundation of the Atomic Theory.

The fundamental assumptions of Dalton's Atomic Theory can be stated as follows:

(1) Every elementary substance is made up of minute indivisible homogeneous particles called atoms.

(2) Each kind of atom possesses a definite and constant weight.

(3) Chemical combination takes place between atoms.

Since its formulation Dalton's theory has been subjected to repeated assaults and as a result of recent advances in physical science his first two assumptions have lost their strict validity. Nevertheless Dalton's atoms still constitute the building stones of our chemical science and still serve to represent the composition of, and the reaction between, chemical substances.

It may be said that through the formulation of Atomic Theory Dalton provided the final and absolute proof regarding the conservation of matter, and that his service to chemistry is on a par with that of Newton to astronomy. The first printed account of his Atomic Theory was published by Dalton himself in 1808 in Part I of his "New System of Chemical Philosophy". He constructed a system of notation for graphically representing atoms and the composition of chemical compounds ; and he also determined the values for relative atomic weights of different elements. But these never came into general use in view of better and more rational symbols subsequently introduced by Berzelius, who also supplied more exact values for the relative atomic weights.

From the beginning of his career Dalton was very fond of making meteorological observations, which he made into a great hobby and continued till the very evening before his death. Dalton died in his bed after retiring for the night at the end of his day's work. He made altogether no less than 200,000 meteorological observations.

Dalton was invited to deliver a series of lectures at the Royal Institution in London in 1803-4 when he publicly announced for the first time the discovery of the Atomic Theory and the Law of Combination in Multiple Proportions. By his unceremonious and unassuming behaviour, and notably by his use of the country dialect, he created a sensation in the polished, genteel and fashionable society of London. On his side, he, too, was shocked by the bustle and din of the great metropolitan city and wrote "London is a most surprising place, worth one's while to see once, but the most disagreeable place on earth for one of a contemplative turn to reside in." Dalton was invited to deliver lectures also at Glasgow, Edinburgh and other places, and received scientific honours from almost all parts of the world. In 1816 he was made an Associate of the French Academy—the highest dignity awarded to any foreigner. In 1822 he was elected a Fellow of the Royal Society and in 1826 the first Royal Medal of the Society was awarded to him.

With the simplest possible apparatus that can ever be imagined Dalton achieved results of far reaching consequence. A penny ink-bottle closed by a cork with a tube fixed in it, a couple of ordinary apothecary's scale and one or two thermometers serve as typical examples of the apparatus in his stock.

His habits were very simple, methodical and uniform. He practically spent every day all his time in the laboratory except on Thursday afternoon, when he would play a game of bowls with his friends and afterwards refresh himself with a pipe of tobacco. He was a very early riser and would repair immediately to his laboratory. A lady living opposite to Dalton's laboratory in Manchester once remarked that she could know her time almost exactly to a minute from seeing the Doctor open his window for reading his thermometer.* In fact, he spent all his waking hours for the pursuit of science. Dalton lived a single life and used to say, when questioned by friends, that he had no time to marry. His holidays were few and were mostly spent in the lake districts of England ascending mountains, measuring their heights by his self-made barometer, determining dewpoint and collecting samples of air at different altitudes for analysis in his laboratory at Manchester.

Dalton was colour-blind and could not distinguish between red and green ; a phenomenon discovered for the first time by him in 1794 and that in himself. It, therefore, goes by the name of Daltonism.

Dalton was a rather poor speaker. When as President of the Manchester Literary and Philosophical Society he had to make some comments on any paper read before the Society, it is reported that he would have satisfied himself simply by saying "This paper will no doubt be found interesting by those who take an interest in it."

With utter contempt for wealth Dalton lived a life of self-imposed poverty. Late in life he was relieved from the drudgery of his tuition and the worry of earning his bread by a Royal Grant of £150/-, afterwards raised to £300/- per annum.

Dalton was held in great esteem and love by his countrymen, specially by the people of Manchester who already raised in his life-time a sum of £2,000/- for his statue. After his death, on the day of his funeral many mills and shops of the city were closed. An important street of the city was named after him. Dalton Chemical Scholarship was established in 1866 in Owens College, Manchester, to perpetuate his memory. This was the first scholarship in England awarded for original research.

P. Ray

* A similar story is told of Immanuel Kant, the German philosopher, who was also a bachelor like Dalton.

THE GYROSCOPE AND ITS APPLICATION

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Introduction

THE "Gyroscope", or "Gyrostat" as some calls it, has been for a long time one of the mysterious scientific toys apparently disobeying the laws of mechanics. The gyroscope is, however, only a glorified scientific name for a spinning top. Such a top has a unique tendency for retaining its orientation in space and resents, while spinning, any change of orientation when a force is applied to do so. The size of the gyroscope varies from a few ounces to a few tons according to its use and application.

As early as 1743, Mr Serson, an ingenious mechanic took a hint from the axial rigidity of a spinning top in space and developed an instrument which was in fact a gyroscope. He took a polished metal disc provided with a spindle and set it rotating. With the help of this elementary gyroscope he wanted to establish an artificial horizon at sea and undertook experiments to that end, which he could not unfortunately complete owing to a disaster. After him, George Graham studied this instrument and tried many experiments to establish its properties. About 25 years later Admiral Fleurias constructed a gyroscope to establish the artificial horizon at sea.* His gyroscope had a rotor weighing about 175 grammes with a speed of rotation of 4800 r.p.m. and was driven by means of a jet of compressed air. Due to mechanical defects its speed did not go up very high, and the instrument did not prove to be of much use. In 1810, Bohnerberger successfully constructed a gyroscope of elementary type with a spheroid rotor.

In 1836, Edward Lang read a paper before the Royal Scottish Society of Arts, suggesting an experiment with an instrument similar to a gyroscope, by which rotation of the earth could be directly proved. After 16 years, in 1852, the French physicist Leon Foucault quite independently took up this experiment and called the instrument a "Gyroscope", a name which has persisted since then. But Foucault's experiment did not attract widespread attention, till it was repeated by the British Association in Liverpool meetings later. The gyroscope was utilized by Prof. Piazzi Smyth in 1856 to stabilize astronomical telescopes at sea. Attempt was also made to couple a gyroscope to the equatorial mount of a telescope so that the latter remained fixed in space.

Until the end of the last century, the gyroscope was however an instrument of demonstration only, but since then its practical applications have increased at such leaps and bounds that gyroscope is today one of the most powerful appliances at the disposal of seamen, aviators and railway men during peace and war.

* Due to rolling and pitching of vessel, and in fog, it is very difficult to make any observation, with reference to natural horizon. For this an artificial horizon which will maintain horizontal position in spite of rolling and pitching is needed for correct observation at sea. For instance, for sextant observation of altitude, a steady horizon may be procured by attaching a mirror to the support of the gyroscope and setting it once for all by means of a spirit level.

Physical Principle of Gyroscope

Before discussing the various modern applications of gyroscope, we shall do well to examine briefly the physical principles involved in its working. All rotating bodies show gyroscopic phenomenon, but its effect is observable only when the angular momentum or the moment of momentum is large. As is well known from simple principles of dynamics, the angular momentum of a rotating body depends upon three factors: (1) the massiveness of the rotating body, (2) the speed of rotation and (3) the square of the distance at which the mass is effectively situated from the axis of rotation.

These three physical factors clearly suggest that to get a pronounced gyroscopic action, the rotor must be of a heavy material, the mass should be disposed as far away from the axis of rotation as practicable, and at the same time, the speed of rotation should be appreciably high. The rotor must be well balanced and its mounting should be free to permit smooth rotation at high speed.

A simple form of gyroscope is represented diagrammatically in fig. 1. "A" is a heavy rotor in the form of a fly-wheel free to rotate about its spinning axis B-B′, which is called the axle of the rotor. It is mounted on the ring which turns freely about the vertical axis V-V′, which is in the plane of the wheel intersecting the spinning axis at right angle. The rotor with its new fittings is again mounted on another ring in such a way that it can rotate about the horizontal axis H-H′ which intersects the vertical axis at right angle. The spinning axis and the vertical axis are always at right angles to each other; so also the vertical axis and the horizontal. But the spinning axis may make any angle with the horizontal axis *i.e.*, it may be in any direction horizontally and, therefore, in any direction in space.

Two important physical properties of its motion guide the application of the gyroscopic phenomenon. The first property is the rigidity of the direction of its axis of rotation and plane of rotation relative to the space ; this enables the gyroscope to be carried about on its support in any manner without changing the direction of its axis of rotation. The second property is what is known as "precession". When a pressure is applied against the supporting rings of the gyroscope with its rotor spinning, a peculiar phenomenon is observed. Suppose the pressure be applied so as to move the gyroscope about its horizontal axis. The supporting ring, instead of moving

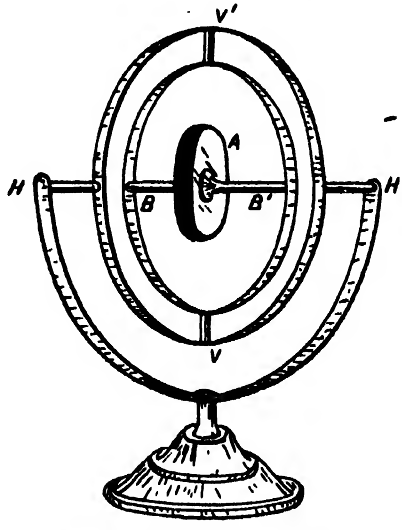

Fig. 1. Elementary Gyroscope.

in the direction of the applied pressure, will resist this pressure and move about the vertical axis of the gyroscope at right angles to the applied pressure. Similarly, if a pressure be applied about the vertical axis of the gyroscope it will resist this pressure in this direction and will move about the horizontal axis. Practical application of a gyroscope requires restraint or control of its freedom according to the need of the purposes.

Applications of Gyroscope at Sea.

(1) *Gyro-Compass.*—In 1883 and 1884, at the meetings of the British Association at Southport and Montreal, Lord Kelvin suggested a method of constructing gyrostatic compass. Now-a-days almost all the big ships are equipped with a gyro-compass. Its advantage is well appreciated by the naval authorities all over the world. The presence of great masses of iron and steel seriously impairs the accuracy of the magnetic compass, and as such magnetic compass is not dependable where high degree of accuracy is required for the gun-fire control. Both the properties of the gyroscope, *viz.*, its rigidity in space and the precessional characteristics, have been utilized in the gyro-compass. The actual instrument on a big liner consists of a wheel weighing 50 lbs. and driven by an electrical motor at 5,000 revolution per minute. It is supported on horizontal bearings inside a vertical ring. This ring is in turn hung from the centre of the compass-card. The North-South axis of the compass-card is first set up in true geographical North-South axis of the earth and the gyroscope is allowed to run. Then the compass will show always the true north.

(2) *Gyro-stabilizer.*—In order to increase comfort and pleasure in ocean travel and to reduce stresses and strains imposed on a ship's frame-work during rolling in a heavy sea, different instruments have been devised to stabilize the pitching and rolling of the ship. In 1907, gyroscope was utilized by Schilick in such a device. His method proved successful. The gyroscopic stabilizer designed and developed by E. A. Sperry, however, appears to have achieved the greatest measure of success in this direction. This stabilizer is a compact unit generally located below the deck and on the centre line of the ship. It consists essentially of a rotor of special steel weighing from a few pounds to several hundreds of pounds and having a speed of rotation of about 18,000 r.p.m. It is supported in a casing which is on the horizontal 'Thwartship' (*i.e.*, across the ship) gudgeon bearing so that the rotor axle, when central, is vertical with the ship on even keel or at perfect rest. The only apparent movement of the stabilizer other than the spinning is a precession fore and aft the 'Thwartship' bearing. In doing so the gyro-stabilizer exerts a proper force against the action of the waves as they tend to roll the ship. The gyro-stabilizer quenches the force of each wave and never allows the ship to roll more than 3 to 4 degrees. The advantage of a non-rolling ship consists not only in the physical comforts of the passengers but also in the use of less power needed to propel the ship. Sister instrument of the gyro-stabilizer is the roll and pitch recorder which records the amplitude of roll and pitch of a ship.

(3) *Gyroscope for Steering Torpedoes.*—L. Obry of Trieste, sometimes an officer of Austrian Navy, was the first man to utilize a gyroscope to steer a torpedo. The gyroscopic steering of torpedoes has now found universal use. The principal member of the torpedoe's mechanical crew-is a gyroscope. Its rotor is a bronze fly-wheel of the size of a tea-cup saucer which is set whirling at 18,000 revolutions a minute by means of a jet of compressed air. It is connected to a small engine which operates the directional rudder. The gyro-pilot, through the engine and the rudder, corrects instantly any deviation

of the torpedo from its aimed course. The human pilot may err but the gyro-pilot never does.

Sperry's Gyroscopic Rail Recorder

E. A. Sperry, pioneer of gyroscopic instruments has utilized the services of gyroscope in studying the condition of rail-road. This instrument is the only means of obtaining a stabilized vertical within a running train, uninfluenced by the disturbing effects of the movements of the train. The gyroscope, jointly with the vertical seeking tendency of a pendulum, provides a means for construction of this apparatus with which to obtain exact replica of the behaviour of the track as the heavy train passes over it. In actual practice, a pendulum is connected to a gyroscope which remains uninfluenced by the train's movement. The pendulum seeks to remain vertical and is able to record all the defects in the rail-road. With the help of this apparatus almost all the conditions of the rail bed can be determined. It is capable of recording accurately the difference of elevation of the two rails both on curve and straight sections of the railway and also the location of rail spread and rail depression. Moreover, it can record the depth of low rail joints and all the inequalities in the railroad bed at the time when the rails are actually subjected to impact of the train passing over it at normal speed.

Gyroscope and Mono-rails

The use of gyroscope in controlling a railway car was first introduced by Louis Brennan, when he exhibited his mono-rail car model. The car was driven over a single rail and its balance was controlled by a gyroscope. In December 1909, Mr Brennan exhibited a much larger mono-rail car measuring $40 \times 13 \times 10$ feet, weighing 22 tons and carrying 40 passengers. The balance of the car was preserved by means of two gyroscopes weighing three quarters of a ton each and spinning in vacuum at the rate of 3,000 r.p.m. Both the car and the gyroscopes were run by gasoline motor and the car preserved the balance under the severest tests such as the sudden shifting of passengers from one side to the other. Precessional action due to gyroscopic motion which would have tended to over-turn the car slowly was obviated by frictional devices.

After Brennan Scherl, a German technician of Dresden, exhibited his car controlled by gyroscopes run by electric motors. The rotors revolved at 8,000 r.p.m., and the weight of the rotors was 6 per cent. to 7 per cent. of the total weight of the vehicle. Better and improved control devices have now practically eliminated accidents.

Gradually gyroscopic controlled mono-rails are being improved upon, and in future it may demand a proper place in railway organizations of the world.

Gyroscope in Aviation

It is in modern aviation that gyroscope has played by far the greatest part. Blind flying, long distance flying and flying in odd days would have been impossible, but for the gyroscope. In bad weather, in the midst of fog and cloud, gyroscope is the only hope before the pilot. In long distance flight when the pilot wants a relieving partner, he has his gyro-pilot to take the full control of the plane from him.

A man can at any time feel his attitude in space through three senses, namely, (1) his eyes, (2) his ears and (3) his deep muscular and nerve sense *i.e.*, when the pilot goes up to higher altitude he feels a peculiar nerve sensation due to low atmospheric pressure and his tilt in space. In clear days an aeroplane pilot can use his eyes to keep the aeroplane in normal flight with respect to natural horizon. But what happens in the dark night in foggy and sultry day when the visibility is extremely poor, when all the senses of the pilot are of no avail to determine the attitude of his flight with respect to horizon, and when his sense of balance is confused and his spatial orientation inaccurate? Just to relieve the pilot from his confusion and to make his position secure, the modern airplane is equipped with three blind flying instruments. These are:

(*i*) *Gyro-horizon or Artificial horizon.*—The chief member of these groups of instruments is the 'Gyro-horizon' better known as artificial horizon. This instrument gives the pilot a real direct reading indication of his flight attitude for bank, climb or glide. It is just a substitute for the natural horizon when it is obscured.

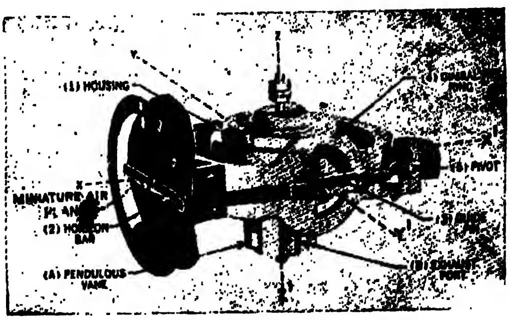

Fig. 2. Gyro-Horizon.

Figure 2 represents a Sperry's Gyro-horizon taken out of its case. The gyro-element in this is a heavy brass rotor (about 6 oz.) with 'bucket' depression round it. The rotor is capable of rotating at the speed of 12,000 r.p.m. approximately about its axis *Z-Z'*, *i.e.*, about its steel shaft. The rotor is mounted inside its housing and driven by the air

pressure (a vacuum of 3 to 4 inches of mercury is maintained in the case which causes the air to rush in the housing through an air filter and strikes the buckets of the rotor, making the later spin). The rotor with its housing is mounted in a glimbal ring (4) and is free to rotate about the "a thwartship" (*i.e.*, pitching) axis Y-Y¹. The whole mechanism is mounted inside the case of instrument and pivoted about the longitudinal axis X-X¹; (2) is the pointer bar carried on an arm pivoted at the rear of the glimbal ring and is controlled by the gyro through a guide pin. There is a pendulum arrangement suspended from underside of the gyro-housing. This arrangement consists of four exhaust ports and four pendulous vanes controlling the air coming out of these exhausts, the reaction of which keeps the gyro axis upright in straight flight.

When the aeroplane noses up, the plane of the gyro remains horizontal and the pointer bar goes down. Thus the pilot observes the miniature airplane of reference of the instrument above the pointer. Reverse is the case when the aeroplane glides or noses down. When the airplane banks or tilts about its horizontal axis, the gyro, by its natural tendency, remains fixed in space, but the case of the instrument with its miniature reference airplane tilts with it. Thus from the behaviour of the miniature airplane, the pilot knows his flying attitude in space, without any reference to his senses.

(*ii*) *Gyro-directional.*—The second member of the blind flying group of instruments is the directional gyro. Due to the rolling, pitching and turning of an aeroplane, the magnetic compass swings and takes time to come to rest. The psychology of the pilot is to turn his machine and cause more swings on the compass in order to follow the magnetic compass in its state of swing. Thus the magnetic compass alone is insufficient for steering the plane accurately, hence the necessity of coupling it with a directional gyro.

Figure 3 shows a Sperry's Directional Gyro taken out of case. The directional gyro is a horizontal axis free gyro provided with an azimuth card and setting devices. The rotor differs slightly from that of gyro-horizon in its design and is capable of spinning about its horizontal axis H-H¹ at about 10,000 r.p.m. driven in the same principle as the gyro-horizon. The rotor is mounted in a gimbal ring which is free to turn about the vertical axis V-V¹ ; (4) is a circular card calibrated in the same way as that of a compass card, attached to the vertical ring. The card can be read through an opening of the case which is closed by a glass window and thus it gives the bearing of the instrument. Due to the rigidity of a gyro, the whole system remains fixed in azimuth, and the airplane moves around it. There is a synchronizer gear and a pinion arrangement by which the instrument can be set and reset by stopping operation and again can be made free to operate according to the will of the pilot. The rotor is kept upright with the help of two parallel air jets which drive the rotor. The instrument is set and reset from time to time with the magnetic compass.

(*iii*) *Turn and Bank.*—The third member or the junior partner of the blind flying group is the turn and bank indicator. It consists of an air driven gyroscope mounted in a single gimbal ring which carries the pointer and is free to turn about the fore and aft axis. Its movement is restrained by a spring adjustable for calibration, and for the prevention of violent movements, there are two dash pots. Any turning of the plane will cause the gyro to precess, and the pointer will then indicate the right turning and rate of turning of the plane. The bank indicator which indicates the lateral attitude of the flight skid, side slip etc., is a curved glass tube as shown in the Fig. 4. The tube contains a liquid (non-freezing type) and a black ball, and is sealed. On normal straight flight the ball remains between the two radium painted line; the back of the tube is also painted with a radium salt so as to make it visible in the dark. In fact it is a kind of spirit level.

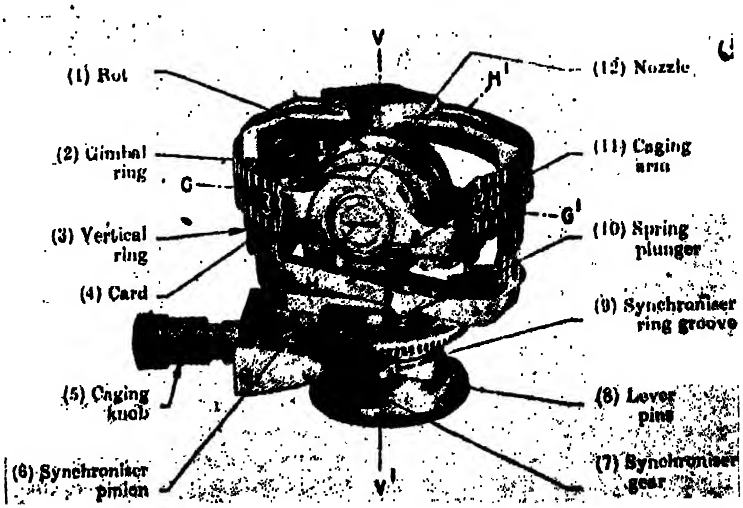

FIG. 3. Gyro-Directional.

All these blind flying instruments have their respective operating limits. These are parallely con-

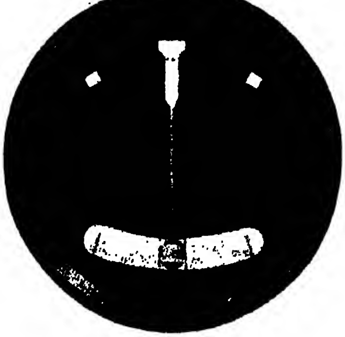

FIG. 4. Turn and Bank.

nected to a vacuum valve system connected to a vacuum pump and to the system of Venturi tubes as shown in the Fig. 5, and are installed on board the ship. Pressure inside these instruments is controlled and kept always at 3 to 4 inches of mercury

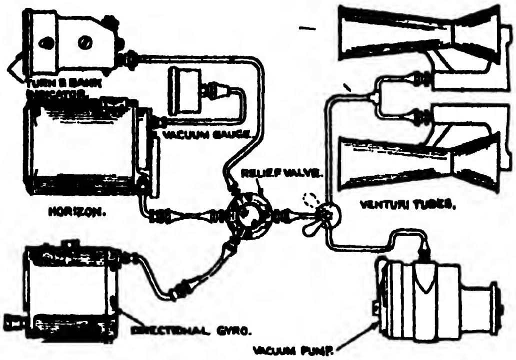

FIG. 5. General Connection.

below the atmospheric pressure so that air gets in through the air filters and forces the gyro elements to run. All these instruments must be allowed to run for 5 minutes before the plane takes off so as to assure that the gyros have attained their operating condition.

GYRO-PILOT IN AID OF LONG DISTANCE FLIGHT

The idea of stabilizing an aeroplane with the help of a gyroscope is not new. At first, inventors seemed to have the idea of keeping an airplane on its course by the sheer force of a gyroscope which would grasp the airplane in a giant hand and compel it to preserve an undeviating direction. But it was soon proved mathematically that it would require a heavier gyroscope than the aeroplane would carry. In 1914 the Sperry aeroplane stabilizer won the 'grand prix' in Paris for safety in flight. This apparatus consisted of four gyroscopes controlling the aileron and elevator. After this, the gyropilot proved an unique instrument for mechanical control and stabilization of an aeroplane. It has been observed that a human pilot soon becomes tired and fatigued and looses his course if he is to keep to his routine task of operating the flying control and maintain its course and attitude in long flight. "Gyropilot has solved this problem as it takes the control from the human pilot and keeps the course of machine all right during long flight". Fig. 6 is a gyropilot or complete mechanical pilot.

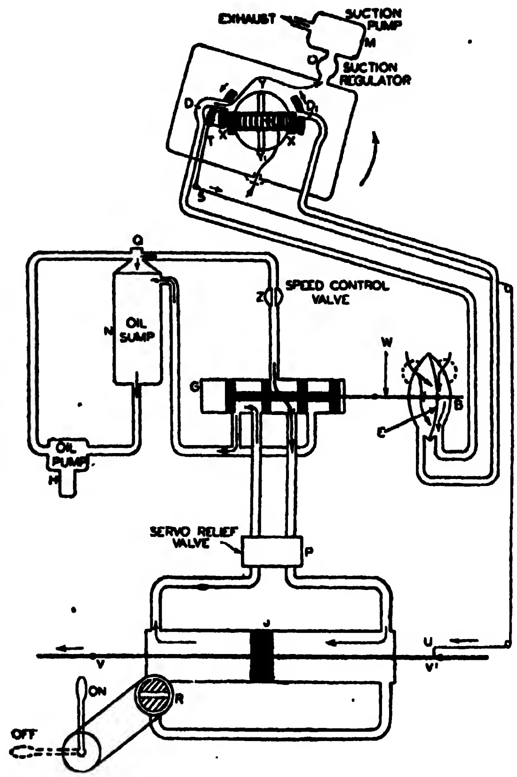

FIG. 6. Gyro-Pilot.

The "brain" of the gyropilot consists of two gyros, one similar to gyro-horizon and another to gyro-directional. The main part of the brain which is similar to gyro-horizon controls the ailerons and the elevator of the plane, while the other part of the brain similar to gyro-directional controls the rudder, *i.e.*, the directional reference.

The "nerve" system consisting of the air relay B and the balanced oil valve, E is a diaphragm, both side of which is connected to the exhaust opening D—D_1 of the air pick of X—X.

The "muscular" system of the instrument consists of three hydraulic servo-cylinders, one of

which is shown in the Fig. 6. Servo oil enters from one end of the cylinder and moves the pistons thereby exhausting the equal amount of oil from other side and takes it back to the oil sump. The piston rod V—V′ is connected to one set of the control cables of the aeroplane. When the plane is piloted by a human pilot, the handle is in "off" position. The valve R opens, the oil flows through the by-pass tube and controls can be moved freely by hands.

By means of a vacuum pump the rotors of the gyros are allowed to run. O is a suction regulator which regulates the air suction inside the gyrobox and allows the rotors to run at a pressure of 4 inches of mercury below the atmosphere. The oil sump N carries the reserve servo oil; Q is a valve which regulates the oil pressure from the pump and permits it to circulate through the sump whenever the balanced oil valve cuts off the circulation to servo unit. P is one of the servo relief valves by means of which human pilot can take the charge of the aeroplane when the system is in operation; Z is a speed regulator valve which regulates the oil speed to servo unit and thus controls the speed of gyro-pilot's control operations. A cable is connected to the servo piston rod at U running to a follow-up pulley S on the gyro box which controls the gear and is ultimately connected to the air pick off, X—X′. In normal level flight, the suction pump, drags air equally through the exhaust parts D—D_1 at the gyro. This equalizes the pressure on both sides of the diaphragm E. The arrow mark of the air relay shows how air is drawn in. When the oil valve G is in central position, the servo piston movement away from the neutral is stopped. Whenever there is a variation in the attitude of the flight the relative movement between the boxes and the gyros (gyro remains fixed in space and the gyro boxes move) make unequal suction through D—D_1, thus admitting unequal quantities of air through the relay valve. In this way unequal pressure is maintained on either side of the diaphragm E causing it to yield on one side and operate the spindle W attached to the diaphragm. The spindle in its turn opens and closes the ports of the oil pressure system G—admitting oil to either side of the piston of the servo unit. The servo-unit is connected directly to main control cables of the plane (not shown in the diagram) which prevents the deviation of the plane from the desired direction. We, therefore, see that the main energy is supplied not by the gyros but by the servo oil pump driven by the engine. The relative movement of the gyroscopes and their container controls the distribution of oil from high pressure system to the control actuating mechanism.

Flight ray.—The most recent use of gyroscope in aviation is Sperry's newly invented "Flight Ray". In this instrument, the combined action of gyro-horizon, direction-gyro, turn and bank and altimeter is focussed on the luminous screen of a cathode ray tube. With a single observation, the pilot can read the operations of all the members of the instruments. Thus by combining gyros with a cathode ray tube the task of the pilot has been considerably simplified by the inventors and engineers. This flight ray has undergone severe tests at Indianapolis airport and many blind landings depending solely on the indications of the flight ray have been successfully made during recent years.

This war has seen many new uses of the gyroscope. One of the most interesting use is gyro-control gun-turret of a tank. This type of tanks were first used by the Russians in the eastern front. The gun-turret is coupled with a gyroscope, the turret-gun of the tank is first aimed at a particular direction, and the control of the gun is maintained by the gyroscope. The gyroscope, by its properties, never allows the gun to change its direction, and the tanks go on as they like but the guns go on firing their shells in the aimed direction. The advantage is that the tanks, by moving in zigzag course, viciates the aim of the enemy, but its own aim at the enemies is not lost.

Another achievement of the gyroscope is the gyro-control unit of the "flying bomb". Construction of the flying bomb still remain a matter of controversy. But the out-line of this can be drawn as following. Flying bomb carries its explosives inside a chamber in its main fuselage. It is propelled by jet propulsion method of rocket system. The fuel used is petrol. The control unit with which the direction of the bomb is kept fixed, is a gyro-pilot similar to one which has been explained before. According to the distance of the target the calculated quantity of fuel is charged. On reaching the target the fuel is exhausted and a lever operates the gyro-pilot which forces the bomb to dive at an angle of 60° to the horizon and strikes the target. Explosives burst in a fraction of a second after its striking.

The use of gyroscope is more and more being appreciated by inventors, amateurs and engineers and they are using it as a means of mechanical stabilizer in space. It has so far proved its worth quite satisfactorily. In future, it may create more wonders in the field of inventions.

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PLANT BREEDING IN INDIA

Dr C. D. DARLINGTON, F.R.S., has an interesting article on "Plant Breeding in India" in a recent issue of *Discovery*, wherein he has analyzed some of the causes of the failures of agriculture in India and offered suggestions of improvement through plant breeding. He referred to the systematic and unchecked deterioration in the productivity of Indian soil during the last 40 or 50 years, in which time other countries, notably U. S. S. R., U. S. A., Britain and Sweden, were busy improving their old and traditional methods of cultivation and devising fresh applications of science to the progress of agriculture. She is no longer reckoned with as the greatest storehouse of plant wealth, which she used to be in the old days.

Since then her population has increased four fold ; but her land productivity has miserably failed to keep pace with this rate. During the last 50 years she could not increase her acreage under wheat by more than 50 per cent., nor could she arrest the steady decline in the average yield per acre, which has fallen from 0·38 to 0·30 ton. In course of the last 30 years, her area under oil seeds, fruits and vegetables and other vitamin crops has gone down from 5·7 to 4·8 million acres with the consequence that fruits which once grew in abundance in India have now to be imported from abroad. The recent famine which has overtaken parts of India and whose menace has not yet been lifted altogether from the country has its origin, in the opinion of Dr Darlington, in the deterioration of the land productivity and the absence of efforts on the part of the powers that be to harness science to the promotion of agriculture.

Dr Darlington traced the development of plant breeding as a science and alluded to the progress made in other countries in this respect. First steps towards plant breeding were taken some 200 years ago when private firms made their appearance in Europe with a view to raising seeds for the cultivator. Before that the farmer used to breed his own seed and did not usually make any attempt to separate the various types of the same grain and had often sown mixtures of different grains, such as wheat and rye. The advent of such private firms made possible the selection of better seeds of one particular colour, quality and time of ripening and was soon responsible for the production of improved grains, pulses and vegetables in general. Thanks to the pioneering work of Keen and Laxton, modern special straw berries were grown in England, while Vilmorin in France 'created the modern sugar-beet, raising its content of sugar from 6 to 16 per cent'.

The success of the new enterprise soon brought into existence numerous other private firms. The gradual expansion of seed trade, all in private hands, led in course of time to unfair competition, loss of quality and other complications. Next important step was, therefore, taken when modern State Institutions responsible for the control of seed trade were created. The research centres now existing in Moscow, Washington, London and Delhi carry on scientific work relating to the control and breeding of new plants.

Dr Darlington referred to some modern practices in hybridization. Methods involving the use of drugs and X-rays are now available by which one can change the very heredity of plants and make them larger or smaller, annual or perennial. Species hitherto uncrossable have been crossed by chemical means and the sterile hybrids made fertile.

The production of quinine in India is not sufficient for millions of Indians suffering from malaria. It is not enough to say that the *cinchona* plant does not flourish in every part of India. By experiments on plant breeding 'new types must be found and new hybrids raised'. In this connection Dr Darlington mentions how in Russia, Sweden and Canada great areas have been brought under cultivation by making new plants to suit them. Thus new frost-resistant apples, hardy rye-wheaet hybrids, drought resistant or sand-binding grasses and new forest trees have been successfully produced. In 1933, the United States introduced a new hybrid maize seed for cultivation, and by 1939 some 20 million acres came under hybrid maize all over U. S. A. The great thoroughness with which work on plant breeding is being carried on in U. S. S. R. is reflected from the fact that the State Agricultural Organization has a staff of over 20,000 workers to control plant breeding.

Recent work on plant breeding at the Indian research stations has clearly indicated the possibility of improving crops, such as wheat, cotton and sugarcane, already grown in this country. Despite these works, India with her rich and varied storehouse of tropical plants largely unknown has hardly made a beginning and has not certainly touched the fringe of her vast problem of plant breeding.

Dr Darlington has the following plan to offer in the direction of plant breeding if full utilization of India's rich treasure house of plants is to be effected along modern scientific lines:

(1) Collections of the main economic plants suitable for India should be assembled and tested. These should not be confined merely to the species of the systematic botanists but should also include the local varieties of the farmer.

(2) Botanic gardens should be properly organized and developed in order that they may function as places of acclimatization of new species and new varieties of useful

living plants, oil palms, citrus fruits, bananas, fibre plants and timber trees which can be sorted out by trial and experiment.

(3) New stations should be established for dealing with special crops which can be speedily turned to advantage either for home food production or for export.

(4) Elaborate plans to raise new plants by hybridization should be developed; great areas of jungle and desert are lying fallow for want of a crop suitable for these regions, and accordingly new hybrids suited to such areas will have to be created.

(5) The plant breeders should work in laision with industrial workers, as a knowledge of the plant and its cultivation alone is not enough.

(6) The plant breeding research stations should maintain close contact with the cultivator who should be made to realize the significance of recent results of scientific research. New plants, whenever developed, should be brought to the cultivator and its success demonstrated to him.

(7) The Government must take the responsibility of distributing seed of improved varieties to the peasant, as otherwise the work in the research station will be simply wasted.

(8) Greater facilities for transport and communication should be created, and conditions of agricultural marketing should be improved. "A Government", as Dr Darlington has most aptly put, "which is paying one lot of people not to raise pigs or potatoes cannot be expected to pay another lot of people to breed bigger and better pigs and potatoes."

Plant breeding has a great future in India. Application of scientific methods has already made possible the cultivation of better sugarcane, tea, coffee and a number of other crops, and henceforward the policy of scientific plant breeding should be pursued more vigorously than has been hitherto possible. Broad vision and working according to long-term planning can alone solve India's problem of feeding her population on a reasonable basis of health and nutrition and remove the menace of recurring famines to which she has been condemned during the last one hundred years or two.

S. N. Sen.

OBITUARY: PROFESSOR BIDHUBHUSAN RAY

We deeply regret to record the death of Dr Bidhubhusan Ray, Khaira Professor of Physics of the University College of Science and Technology, Calcutta, who passed away on July 29 at his Calcutta residence. He had a severe attack of Coronary Thrombosis in February, 1940, while working in his Laboratory, from which he never fully recovered. He was only 50 years of age at the time of his death. Professor Ray was a physicist of international fame, and Indian Science has suffered by his death an irreparable loss.

Born in July, 1894 in a respectable family in the District of Faridpur, Bengal, Prof. Ray had to struggle hard with poverty for his early education. Being endowed with great talents, and possessed of industrial habits he obtained many scholarships and distinctions during his academic career at the Ravenshaw College, Cuttack and the Presidency College, Calcutta. He took the M.Sc. degree of the Calcutta University in 1918, shortly after which he was nominated for a post in the Bengal Civil Service as being one of the most meritorious students of his year. The late Sir Asutosh, however, encouraged him in his scholarly ambition, and his personal aptitude for research led him to reject the offer in spite of the financial hardship which such a step entailed for him. His early researches were carried on under Prof. C. V. Raman. He obtained his Doctorate degree in Science in 1922 by a thesis on scattering of light which brought him great reputation. It is well known that when light passes through a medium containing small particles in suspension, it decreases in intensity due to scattering by the medium and the nature of the transmitted light depends on the suspended particles. As the particles grow in size, the suspension refuses to

Prof. B. B. Ray

transmit, first the shorter waves, and finally, the whole visible spectrum. This is precisely what is to be expected from the theory. But in 1914, Keen and Porter discovered the remarkable fact that

after a certain stage the suspension again transmits, light, the colour being at first indigo, then blue, blue green, greenish yellow and finally again white. This remarkable reappearance of the transmitted light could not be explained by any hypothesis, and naturally doubts were felt regarding the actual presence of the effect. By making elaborate and accurate experiments Prof. Ray, in collaboration with Prof. Raman, not only demonstrated the existence of this effect but also succeeded in giving a satisfactory explanation of the phenomenon by considering the interference of the direct light with the light scattered by suspended particles. His findings have an important bearing on the colouring of glasses by suspended metal particles and the axial colours exhibited by clouds.

Prof. Ray joined the University of Calcutta as a Lecturer in Physics in 1921. In 1923, he was awarded the Premchand Roychand Scholarship and also the Palit Scholarship for scientific research abroad. While in Europe he worked in the laboratories of Prof. Manne Siegbahn at Upsala in Sweden and of Prof. Niels Bohr in Copenhagen. Prof. Ray's investigations in these laboratories were of great importance and contributed significantly to a revision of a theory regarding the origin of X-ray spectra. It was previously held that X-ray absorption spectra were due to atoms alone and were not changed by chemical combination. By means of a special type of spectrograph, however, made at Prof. Siegbahn's Laboratory, Dr Ray was able to establish definitely that the spectra are actually modified by chemical combination. After his return to India in 1926, he devoted himself entirely to the investigation of how X-rays were modified when emitted by the atom. By passing monochromatic X-rays through carbon, nitrogen and oxygen he discovered in 1930 new lines emitted by these atoms on the longer wavelength side of the primary radiation. These lines were diffuse and broad and had more or less sharp edges on the short wave length side of the spectrum and appear to be something like Raman-lines in X-ray region. Though his results have not been generally confirmed it is still believed by some of the leading theoretical physicists that future experiments performed under suitable conditions, particularly at small angles, should confirm the findings.

Dr Ray went to Europe a second time in 1934 with a Ghosh Travelling Fellowship of the Calcutta University and toured extensively on the Continent, visiting all the leading centres of scientific research. The University of Calcutta offered him the Khaira Chair in Physics in 1935, when he returned to India, in recognition of his scientific achievements. Dr Ray now applied all his time and energy to the organization and equipment of the X-ray research laboratory and also to the training up of a band of young research scholars who would be able to carry on investigations in a truly scientific spirit. It was in his own laboratory in the Science College, Calcutta, that he had the first heart-attack as a result of over work. He initiated researches in several new fields of X-ray, and before his untimely death he was engaged in important investigations on the emission and absorption spectra of elements in the soft X-ray region, which are expected to throw much light on the distribution of electrons in the solid state. He had also been conducting researches on the luminescence of solids under X-ray and similar irradiations with a view to elucidating the problem of extra energy levels in solid. Recently from the study of the fine structure of X-ray absorption edges, he attained interesting results on the nature of ions in solution.

Professor Ray was a fellow of the National Institute of Sciences and was associated with several learned societies of India. He presided over the Physics Section of the 29th Session of the Indian Science Congress held at Baroda in 1942. His presidential address was a masterly review of the work done by himself and his team and was highly appreciated.

Professor Ray was the first editor of SCIENCE AND CULTURE when it made its appearance in June, 1935. Jointly with Professor M. N. Saha, he was also the founder Honorary Secretary of the Indian Science News Association. Although he failed later to continue his active association with the management of the journal owing to indifferent health, he always took keen interest in the affairs of the journal.

Professor Ray had great reputation as a teacher. Always clad in *dhoti* and *punjabi*, Dr Ray was one of the most unassuming men in the University College of Science. He avoided publicity in all its forms and his numerous charities were not known even to his best friends. Prof. Ray had a charming personality, and the wit and sense of humour which he possessed did not leave him even at the last moment of his life. He was religious in temperament and was connected with the Ramkrishna Mission for the last 30 years. He has left behind him his wife, an only daughter, a brother and a sister and numerous pupils, friends and admirers to mourn his loss.

R. C. M.

PROF. B. B. RAY MEMORIAL FUND

At a meeting of condolence, held at the University College of Science and Technology, Calcutta, and attended by the colleagues, numerous friends and pupils of late Prof. Ray, it was decided to raise funds for perpetuating the memory of the departed Professor in a suitable manner. A representative Committee was constituted, to start collections for the Memorial fund. On half of the Committee we beg to approach the friends, well-wishers and pupils of late Prof. Ray as well as those who generously support every endeavour for the growth of scientific research and study in this country for their contribution to the Memorial Fund and request them to send their suggestions to us so that the task of the Committee may be fulfilled in the best manner. All contributions are to be sent to Mr S. K. Acharyya, Treasurer, Prof. B. B. Ray Memorial Committee, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

M. N. Saha,
Chairman.

S. Gupta,
Secretary.

Notes and News

POST-WAR INDUSTRIALIZATION OF INDIA

Post-war industrialization of India formed the subject of an address delivered by Mr Sankalchand G. Shah, Vice-President of the All-India Manufacturers' Organization, Bombay, at the Second Quarterly Meeting of the Central Committee, held on July 23, 1944. Mr Shah welcomed the creation of the new Department of Planning and Development by the Government of India and referred to the appointment of Sir Ardeshir R. Dalal to be in-charge of the new Department as a step in the right direction. He expressed the view that Sir Ardeshir's intimate knowledge of the state of affairs in the country, his contact with the commercial and industrial community and his association with the authorship of the Bombay Plan will enable him to pursue the plan for industrialization of India with vigour and enthusiasm.

Speaking of India's sterling balances, he referred to the bitter sense of frustration India experienced at the decision of the recent International Monetary Conference to exclude the question of abnormal war balances from the scope of the Fund. 'The amounts represented by these balances amassed out of the privations and hardships suffered by the people of India', he said, 'are very badly required for purposes of its reconstruction and of industrial development, and it is particularly from that point of view that I feel that the decision of the conference to evade this issue amounts to putting a damper on our efforts at planning and development. We require this money for enabling us to purchase the necessary capital equipment and machinery, more particularly in the post-war period.'

Mr Shah strongly criticized the Government's present policy, in the name of anti-inflationary measures, of importing large supplies of consumer's goods irrespective of the detrimental effect of such a step on the indigenous industries producing similar goods. The import policy has already placed some of the existing industries into difficulties. Although the Government have sought to justify their policy in the light of the urgent necessity of relieving the scarcity of consumers' goods in the country, the Indian public is at a loss to understand how it is easier for Government to arrange to secure the importation of finished bicycles in preference to importation of some parts and machinery required by the cycle manufacturing industry here to increase its production. Furthermore, the present import policy is utterly inconsistent with the assurances given from time to time since the outbreak of the present hostilities by such official spokesmen as Sir Ramaswami Mudaliar with regard to the protection of Indian industries started or developed during the war in the post-war period. Mr Shah referred to the assurance Sir Ramaswami gave in course of his statement in the Central Legislature on March 12, 1944, when he said, ". . . . in case we (Government) in any form encouraged the development of industries for our war names, we shall make it clear that at the end of the war those enterpreneurs who had come to the assistance of the State and had developed industries would not be left high and dry and to take care of themselves." The import policy has engendered widespread suspicion whether the Government would really stand by Indian industries in the difficult times

likely to face them after the war. He emphasized the need at this stage for a clear declaration by the Government in regard to the fiscal policy which they propose to adopt in the post-war period.

Mr Shah expressed his firm belief in the industrialization of the country as the only possible remedy for the present deplorable state of affairs and finally referred to the following proposals put forward by the A.I.M.O. for the current year.

(1) The establishment and development of really large scale industries for the manufacture of heavy machinery including railway and defence equipment and their ancillary industries. They should form the most important item of our immediate industrial programme.
(2) The concentration on creating public attention on adequate naval defence of the country which when sufficiently developed should provide for the establishment of the two heavy industries of sea-transport and ship construction.
(3) The establishment upon a permanent footing of such industries as the country has been fortunate in having as a result of the war conditions.
(4) The establishment of a first grade institute of higher technology for training technical and executive personnel and for carrying on research in the technique of modern methods of production.
(5) Provision of technical and scientific advise on all problems connected with the establishment and maintenance of industries by firms or panels of technical experts and advisers.
(6) Publication of an industrial journal giving the latest information on all technical and economic problems relating to industries.
(7) The propagation of correct and nationally beneficial ideas on tariff and other policies of Government which will have to be followed in the post-war period in the interests of our industries.
(8) An intensified and countrywide drive by means of propaganda, lectures by eminent scientists, economists and industrialists and the establishment of personal contacts between all who are connected with industries through tours and conferences.

A. I. M. O. AND INDIAN INDUSTRIES

THE Secretary of the All-India Manufacturers' Organization, Bombay, draws our attention to a resolution passed at the recent meeting of the Central Committee of the A.I.M.O., advocating protective Government measures for essential industries, particularly those started during the war. In pursuance of this resolution the working committee now invites interested industrialists to get immediately in touch with the Secretary (address: Industrial Assurance Building, Opp. Churchgate Station, Bombay) to enable the Organization to urge upon the Government, where necessary, to adopt one or more of the safe-guarding methods which include among others, (*a*) protective tariffs, (*b*) bounties and or subsidies, (*c*) guarantee of interest on invested capital, (*d*) facilities for importation of essential raw and semi-manufactured materials, (*e*) provision by means of priorities of suitable equipment and technical assistance.

It is hoped that the parties interested will assist the Organization in its work by immediately forwarding complete statements including, (1) the date of the establishment of the factory, (2) the amount of capital invested, (3) the output and the value of products, (4) the nature of the difficulties experienced in detail, (5) the name of protection desired in detail.

The undernoted types of industries are specially required to supply the particulars sought for: (1) industries started or developed with further capital investments at the instance of the Government, (2) industries which are in the nature of key or defence industries, (3) industries which can be developed into or as adjuncts of heavy industries, (4) industries in respect of which it is essential for the country to be independent of foreign supplies in times of war, (5) industries providing articles serving as ancillaries for other industries, (6) industries utilizing waste products of other industries, (7) industries catering for educational and cultural developments of the country, and (8) industries manufacturing such consumers' goods as are required to raise or maintain at least the minimum standard of life of the people.

POST-WAR TRAINING OF FOREIGN ENGINEERS IN THE UNITED STATES

WE learn from a report in *Science* that the General Engineering Staff of the Foreign Economic Administration in the United States has recently adopted a plan for the post-war training of foreign engineers in the American engineering colleges. The plan has made provision for about 3000 to 4000 foreign students from Europe and Asia at an estimated expense of about $3,600 per student. The period of study has been stated to be eighteen months. The foreign governments concerned, with the advice of the educational leaders of the United States, will select the students and will be required to provide most of the money for their expenses. The Federal Government, however, proposes to contribute an unspecified percentage. All students will receive practical working experience in industry for a third of the course and, while at college, will be under the direct supervision of the college authorities.

We further learn that courses have been developed or are under preparation at the Carnegie Institute of Technology, the Massachusetts Institute of Technology, The Colorado School of Mines, the Illinois Institute of Technology, North Western University, Pennsylvania State College, the Philadelphia Textile Institute, Purdue University, the University of Detroit, the University of Illinois, the University of North Carolina, the University of Michigan, the University of Utah, the University of Wisconsin and Union College.

The plan further proposes to train up some 5000 to 10,000 American technical graduates for foreign service. For, it is the feeling in America that the rebuilding of the industrial systems in the devastated areas of Europe and Asia in the post-war period will necessitate the direct assistance of American engineers.

The American move to open their universities and centres of technical education to train up foreign students for the most difficult rehabilitation work in the post-war period is highly commendable and will doubtless inspire fresh hopes in the war-weary countries outside U. S. A. But we fail to understand on what basis the plan has sought to train only 4000 foreign graduates when it has admitted that as many as 10,000 American engineers may be required for foreign service. Needless to point out that any country outside U. S. A., which will be left with some prestige and national pride, will prefer to build her demolished industrial systems through the efforts of her own engineers and scientific men and will not be prepared to receive American engineers with much enthusiasm. We wish if the U. S. A. could give up ideas of thrusting her own engineers for such philanthropic work and concentrate on the more modest programme of giving training to more foreign graduates to rebuild the unhappy lands of their birth.

COLONIAL RESEARCH FELLOWSHIPS

The report has filtered through the Department of Education, Health and Lands that the Secretary of State for the Colonies has instituted a number of Colonial Research Fellowships to encourage research on problems of colonial interest. The creation of the Fellowships, it is reported, particularly aims at producing a cadre of scientists with special knowledge of environmental and social issues of the colonies and encouraging research on fundamental problems in tropical regions. These Fellowships are open to graduates under 35 years of age from any part of the British Commonwealth and Empire and will carry an allowance of £400 to £600 per year. These will normally be for two years but may be extended for a year and will be tenable in any part of the British Colonial Empire. Provision for 25 Fellowships has been made within the next five years. The award will be made by the Secretary of State for the colonies on the advice of the Colonial Research Committee.

IRRIGATION RESEARCH AT POONA

The Annual Report (Technical) of the Central Irrigation and Hydrodynamic Research Station, Poona (now renamed as Indian Waterways Experiment Station), for the year 1941-42, issued recently, contains important conclusions and notes on river and canal problems, such as protection of bridge piers against scour, control of sand entering the Right Bank Canals at Sukkur, high efficiency siphon spillway to control water levels in reservoirs and divergence from regime in stable channels in alluvium. Experiments were conducted at the Station to control sand entering the Right Bank Canals, and as a result an approach channel was constructed upstream of the Barrage at Sukkur. The channel came into full operation in 1941 flood season and has succeeded in reducing considerably the deposit of sand in the North-Western Canal and the Rice Canal.

The problem of the protection of bridge piers against scours received investigation at the Station. It has been clearly demonstrated that the level at which the stone pitching is laid round bridge piers has a great bearing on the scour of the river bed downstream of the piers. A high level pitching which results in a great depth of the scour has often been found to be the cause of large slips of stones from the downstream ends of piers. The remedy lies, it is suggested, in the low level pitching which will reduce the depth of the scour and largely eliminate the danger of such slips of stones.

The Station also studied, among other things, the problem of erosion occurring at several points along the fore shore of the Hooghly above Calcutta and suggested either the filling of the 'scour hole' or the cutting away of the 'kunckle' as a possible remedy. The Director's observation of the westerly movement of the Kosi River at an average rate of more than a mile per year for 50 years during his deputation to Nepal is another interesting feature of the report.

WORK AT THE *TATA CHEMICALS*

An account of the progress of work made at the *Tata Chemicals* has been reported in a recent issue of the *Journal of Scientific and Industrial Research*. The *Tata Chemicals*, started in 1939 at Mithapur in Okhamandal, a district in the Baroda State, with an authorized capital of Rs. 5 crores, represents a pioneering industrial venture characteristic of the Tatas. The plan for the establishment of this new chemical industry, now claimed as the biggest in India, was drawn up by Mr Kapilram H. Vakil, the present Technical Director of the *Tata Chemicals*, early in 1937. In the same year, the scheme was carefully scrutinized by a committee of experts at London, under the Chairmanship of Mr J. A. Reavell, the distinguished British chemical engineer, and was found to be satisfactory and workable.

The outbreak of the war within a few months of the commencement of work at Mithapur seriously interfered with the execution of the project, and the progress was slow and halting. Despite such wartime odds and difficulties the project has been carried to a successful issue, and the company has started manufacturing several important chemicals which in-

clude, among other things, alkalies, heavy chemicals and marine products. Soda ash is manufactured according to the ammonia soda process, and the plant installed for the purpose incorporates the latest practices in soda-ash manufacture. Soda-ash being the most important starting material for the manufacture of drugs and dyestuffs and of caustic soda and sodium bicarbonate required in the glass, soap and paper industries, its successful production at Mithapur has gone a long way in meeting the need of an important basic chemical in India. Further, plants have been completed for the production of caustic soda by the electrolysis of brine, and gaseous by-products are already being utilized for the manufacture of bleaching powder, liquid chlorine and hydrochloric acid. Other chemicals now being manufactured include zinc chloride, bromides, epsom salts, potassium chloride and magnesium chloride. In fact, the *Tata Chemicals* are now manufacturing all the basic chemicals essential for the production of dyestuffs, fertilizers, glass, drugs and pharmaceuticals.

The chemical works at Mithapur are fast undergoing expansion and have already come to occupy an area of about 60 acres. Some 1500 workers and about 500 skilled personnel including 200 highly qualified and trained chemists and engineers comprise the staff of the *Tata Chemicals*. The whole works have been planned, designed and equipped according to latest developments and have been provided with a well-equipped research laboratory. Moreover, the choice of site for the new chemical industry has been a suitable one from the geological point of view inasmuch as large deposits of high quality limestone in the Okhamandal area and the salt garden at Mithapur provide an abundant supply of important raw materials needed for the industry.

WELDON PRIZE TO PROF. P. C. MAHALANOBIS

We are glad and proud to learn that the University of Oxford has awarded the Weldon Prize to Prof. P. C. Mahalanobis of the Calcutta Statistical Laboratory, the first Indian to be ever chosen for such singular honour and distinction. The award has been made in recognition of his significant contributions to biometric science during the preceding six years.

The Weldon Prize to be awarded every three years was instituted in 1907 in memory of W. F. R. Weldon, professor of biology of the Oxford University. Prof. Weldon was one of the great pioneers of the new science of biometry and founded, jointly with Karl Pearson, another great pioneer, the famous journal *Biometrika* in 1941. The recipients of the Prize which is international in character include such distinguished men as Professors J. B. S. Haldane, F.R.S., R. A. Fisher, F.R.S., M. Greenwood, F.R.S., and E. S. Pearson, all of England, Prof. Johannes Schmidt of Denmark and Prof. J. A. Harris of the United States. Prof. J. B. S. Haldane was the last recipient in 1938 and the Prize was kept in abeyance in 1941.

ANNOUNCEMENT

Short notes on industrial topics, both technical and of news value, are invited on payment basis for publication in the "Technical Research Note", "Notes and News" sections of the Industrial and News Edition of the Journal of the Indian Chemical Society. For each note approved for publication Rs. 2/- will be paid. None of the notes, approved or unapproved, will be returned unless accompanied with requisite postage stamps. Further information can be had from the Honorary Secretary, Indian Chemical Society, Post Box 10857, Calcutta.

SCIENCE IN INDUSTRY

A NEW ORGANIC INSECTICIDE

A new organic insecticide identified as dichlorodipenyl-trichloroethane and abbreviated into 'D.D.T.' has recently formed the subject of much discussion in the lay press as well as in scientific papers. According to a recent Reuter news, D.D.T. is reported to be effective against typhus, malaria, dysentery, enteric, cholera and plague and against insects both as contact and as stomach poison. It works by striking at the carrier of the disease and can kill body lice, mosquitoes and flies which are responsible for the spread of dysentery, enteric fever, cholera and the plague. Further, bugs, pleas, cockroaches, beetles, cabbage worms and aphides fall easy victim to D.D.T. It is, however, non-toxic to man and other warm-blooded animals and also does not appear to hurt plants.

The new insecticide is the result of an intensive search for a suitable synthetic organic compound for the control of pests and insects and such other carriers of diseases. Although a number of organic compounds having insecticidal properties were synthesized, few proved acceptable owing to their toxic effects on man, animals and plants. Their high cost was also no less an important factor. But despite such discouraging facts, the hope of a suitable organic

insecticide non-toxic to man, plants and animals was never given up.

Although the full story of the development of D.D.T. is lacking for obvious reasons, the new insecticide, according to a recent issue of *Scientific Monthly*, is reported to have been first used successfully in Switzerland whence the results were later communicated to the U. S. Department of Agriculture. The chemists of the Bureau of Entomology and Plant Quarantine soon analyzed the compound and described it as dichloro-diphenyl-trichloroethane. The compound is made from chlorobenzene and chloral hydrate and is crystalline in nature. The elaborate tests carried out at the testing laboratories of the Bureau of the Crop Protection Institute have corroborated all the insecticidal properties now claimed for D.D.T. The insecticide has been so far adopted by Army on an extensive scale.

THE CHEMICAL TREATMENT OF WOOD

A METHOD of hardening soft wood through chemical treatment has been reported in *Science*. Developed in the laboratories of E. I. du Pont de Nemours, the chemical process is claimed to make timber markedly harder, stronger, stiffer and more durable. The process has successfully eliminated the natural tendency of wood to swell, shrink or warp with changes in humidity. The hardness of the wood so treated remains unaffected by such varying climates as characterize the tropical jungles and the desert regions. Such woods have further been given a permanent colour throughout the material.

The chemical treatment consists in the use of the organic compound methylolurea obtained by compounding urea with dimethylolurea. Both urea and dimethylolurea are white, water-soluble solids, prepared from ammonia, carbon dioxide and methanol and available commercially at a reasonably low price. Methyl urea is impregnated into the wood to be treated in the form of a solution when the compound reacts with the wood components to form hard, water-insoluble, unmeltable resins within the piece of timber. The formation of resin inside imparts the characteristic hardness to the wood specimen. It is stated that the process may be speeded up through the application of heat, such as kiln drying.

The process may further be applied to harden the outside layers of a piece of lumber sparing the interior. Lumbers so treated have decided advantages in certain types of construction, such as trestles, bridges and towers.

RECENT PRACTICES IN BEET SUGAR CHEMISTRY

DR T. TWOMEY, of the Irish Sugar Company, during his lecture delivered recently to the Irish Chemical Association, has made an important review of some of the recent practices in beet sugar chemistry. He has discussed briefly the various stages of the chemical operation, involved in the extraction of sugar from raw beet juice. Such stages include lime treatment of juice, carbonatation, removal of incrustation, purification, boiling and by-products. The following summary account is based on a fuller report appearing in *The Chemical Age*, April 15, 1944.

The precipitation of non-sugars from raw beet juice is now most effectively carried out by lime milk through two stages in preference to one single operation as it used to be followed until recently. The stages are pre-defection and main liming. Pre-defection may again be conducted in two ways. According to the first, raw juice at a temperature of 40°C is treated with small doses of lime, gradually increasing the alkalinity to a maximum of 0·3 per cent. During the addition of lime, punctuated by a series of pauses, a *p*H equivalent to the iso-electric point of every colloid present is reached and all colloids are coagulated. The juice is then heated and made ready for the main liming. The second method consists in adding enough lime in pre-defection stage to make the juice attain a *p*H value of 10·9, and then wait for 10 minutes before proceeding with the main liming. It is assumed in this procedure that beet juice contains only one or two predominant colloids which will be completely coagulated when the stated *p*H is reached and that the tedious operation of passing through all possible iso-electric ranges is unnecessary.

The lime treatment of juice is followed by the carbonatation process which seeks to remove the excess of lime. This is effected by passing carbon dioxide gas in two stages. CO_2 is first added till the alkalinity is reduced to about *p*H 10·9, after which it is filtered. Gassing is then continued in the filtrate till the percentage of CaO falls to 0·015. In the second stage of gassification, dissolved calcium salts are removed, according to modern view, by their interaction with sodium carbonate. This reaction is made possible by the normal presence of sodium in beet sugar juices. The removal of calcium salts is an important stage as they lead to heavy incrustation on the heating pipes. It should be, however, noted that incrustation cannot be altogether prevented despite every precaution. The scale consists, for the most part, of calcium carbonate, sulphite, phospate, silicate and oxalate and may be removed by boiling it first with dilute hydrochloric acid and then with 8 per cent. caustic soda solution. The descaling of pipes is sometimes effected through the use of suitable scrapers. But a more suitable chemical method of removing the scale remains yet to be developed.

The recent introduction of new synthetic ion-exchange adsorbents to purify sugar liquors has greatly increased the final sugar yield with its conse-

quent reduction in the quantity of molasses formed. The conventional lime treatment usually increases the percentage of sugar in the liquor to 93-94, whereas the ion-exchange method ensures a purity of 99 per cent. The process consists in allowing the juice having a purity of 90 per cent. to pass in succession through beds of cation and anion exchangers. The method further promises to reduce the fuel and equipment costs and simplify the several stages of operation now in use.

The boiling of the sugar solution represents another important stage in the extraction of sugar from beet juice. The success in this stage depends largely upon the effective control of the boiling. Formerly the degree of supersaturation attained during boiling used to be determined by the measurement of viscosity or conductivity of the solution. But as such measurements are made at a particular spot within the pan the results are not representative of the mass as a whole. According to the most recent development, the control of boiling is effected through the study of the boiling points of the sugar solution. The method arose from the discovery that at all pressures encountered in the usual sugar boiling practice the graph of the boiling points of sugar solutions of any degree of supersaturation against the corresponding boiling points of water at the same absolute pressure was a straight line. A formula has been developed from this and an instrument constructed, which records the degree of supersaturation continuously.

The molasses left as a waste product in the beet sugar industry has recently been utilized for the manufacture of a series of important by-products. Yeast and ethyl alcohol were already produced from molasses. An American bio-chemist has lately expressed his view that this waste product may form the starting material of a series of products, such as glycerine, acetone and acetic, lactic and citric acids. It is reported that a motor fuel called Jeanite has been recently obtained by the polymerization of ethyl and butyl alcohols, both derived from molasses. The new synthetic motor fuel has further been claimed to be almost as good as petrol.

PRODUCTION OF RAMIE FIBRE IN INDIA

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RAMIE like cotton is an ancient heritage of India. The use of best fibres from the nettle family of plants in India, China, Central Europe, and America is a noteorthy coincidence in the history of ramie fibre. Whereas the cultivation of ramie is limited now to a handful of cultivators in India, its methods of cultivation and production are still primitive in China, and Europe has abandoned it as a costly fibre. There is, however, a definite urge for increasing its production in America and Japan in present times.

The American farmers have obtained very high yields of ramie fibre from the cultivated crop, their industry has perfected a mechanical decorticating device, has developed a suitable degumming process for the preparation of the fibre, and has also found it adaptable to the standard spinning machinery. They are thus, able to compete with the cheap production of the fibre in China. They claim the fibre not only to be an addition to the textile resources during the war but also consider it an acquisition for all times.

The ramie plant is indigenous to India. Should not India therefore, tap this source for supplementing the country's need for a long staple vegetable fibre or the textile resources of the Allied Nations during the war? In view of the enormous length of the ultimate cells of this bast fibre, its whiteness, lustre, strength and durability of the fabrics made from it, the revival of its cultivation in India deserves backing from Government, the financiers, and the industrialists. It may be mentioned that apart from its textile use, the ramie fibre on account of its high cellulose content which is almost as much as that of cotton, is highly suitable for paper and cellulose acetate manufacture. It is suggested that the Government of India may offer some handsome prize again just as she did in 1869 for a machine to decorticate ramie, for the development of a process to degum the fibre. Indian scientists have hardly any paying objectives for research.

It is pointed out that the cultivation of this fibre in India has no unsurmountable difficulties. While the farmers at least in Bengal and Assam know how to grow the crop, the country needs a long and strong vegetable fibre capable of producing durable cloth, and its production can materially add to the textile resources of the Allied Nations. The only thing wanting is encouragement and a ready market for the product. Under the present circumstances, Indian raw produce can supplement America's yield for war purposes.

The crop needs alluvial or light sandy soil, about 40 inches of rain well distributed throughout the year, and is adaptable to cultivation in irrigated land. India may be able to spare such land in rain-fed and irrigated tracts as well. Furthermore, India grows some surplus short staple fibres and therefore, it may be worthwhile for her to grow ramie instead, which

American industrialists have found to be admirably suited for tropical hard wear, notably for uniforms of the fighting troops.

For general information we give below a short account of the ramie plant, methods of its cultivation, and preparation of the fibre together with its properties as summarised from Robinson (1940).

The Plant

Ramie fibre is obtained from two species of the nettle family of plants, *viz.*, *Boehemeria nevea* and *Boehemeria tenacissima*. They are perennial shrubs suited for cultivation in the sub-tropical regions. The fibre from the two species is indistinguishable. *B. nevea* is the more favoured of the two species in China, Japan, Philippines, and America. The plant is said to need a cool winter for inducing a resting period but not freezing cold which is likely to kill its roots. It can withstand drought after being well established, but needs abundance of moisture for high yields. Moisture at the time of harvesting however, is an unfavourable condition for storing cut stalks.

As the plant is grown for its vegetative stalks which yield the fibre, its cultivation quickly depletes the soil of its nutrients. They have therefore, to be replenished from time to time. After decorticating the stems it is good to return the waste back to the field. The level of nitrogen, phosphorus and potassium in the soil has to be maintained for successful cultivation of the crop. Nightsoil and compost are useful manures tried in other countries.

Culture

The ramie plant is best propagated by pieces of roots. Each piece has to be about six inches long and is planted in a slanting or upright position with the upper end one or two inches below the surface. They are set in rows three to six feet apart and spaced 18 to 24 inches in each row. The shoots grow up in one to two weeks. The root-stock breeds true to the nature of the fibre, and yields one or more cuttings in favourable circumstances even in the first year. Best results are obtained by keeping the weeds out and breakng the soil now and then for soil aeration. Crops from seed are difficult to raise, and less homogenous in fibre character. Harvesting is begun when the flowers make their appearance. A timely cutting may make it possible to have three to four cuttings in a year. A new growth of about 30 inches may follow a cutting within two weeks under suitable conditions. The productive period is for ten years. Maintenance of original fertility and the care taken can prolong the productive period and also increase the yield appreciably. On an average this crop yields 400 to 700 lbs. of prepared fibre per acre annually. The upper limit of the yield may reach 1500 lbs. The major part of the total world production of ramie comes from China and is about 100,000 long tons.

It may be mentioned that the gross yield per acre of the stalk in the U. S. A. varies from 1 to 45 tons. The American analysis of the gross yield is given below.

Stalks and leaves	100%
Stripped stalk	52%
Air dry stalk	10·4%
Decorticated fibre	2·1%
Degummed filasse	1·2%

Preparation of the Fibre

The harvested stalks are soaked in water for sometimes before the fibre is stripped off. At this stage the fibre consists of a brownish outer bark, adhering cortical tissue and much gum. This process known as decortication is carried out by hand in China, while it is done by machine in America and Philippines now. The manual labourers use bone or bamboo implements for scraping the fibre from the stalks. The gummy brownish fibre is then degummed by the action of anaerobic bacteria or by the action of some chemicals the formulae of which are protected by patents. After the fibre is degummed, it is perfectly white and more or less divided into ultimate cells which are flexible enough for being spun. The fibre loses about one-third its weight in the process of degumming.

Properties of Fibre

Ramie is stronger than any other bast fibre, cotton or silk. Cotton and silk excel it in being twistable more easily. Ultimate fibres range from ½ to 20 inches with a diameter of 0·002 to 0·003 inches. The average length is from six to eight inches. Flax is finer than ramie, but ramie has a smoother surface and is more lustrous. It does not throw off linters and is therefore, highly recommended for surgeons overalls, and surgical bandages. It absorbs water more quickly than flax. Chinese use it in the manufacture of various fabrics which compete well with European linen. It is used in the manufacture of table-clothes, napkins, plushes, upholstry cloth, curtains, dress goods, knit goods, and notably for gas mantles. With the help of the cheap labour available in India, the cost of the fabrics made from this fibre is not likely to be more than that of cotton.

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HEAT IN CONTROLLING SEED-BORNE DISEASES OF PLANTS

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THE application of heat or temperature in the art of controlling plant diseases is a new practice dating back from the early 'eighties of the last century'. Prior to this efforts at controlling and curing diseases in plant were directed along such sanitary and hygienic operations as rogueing of diseased plants, eradication of alternate host-plants near about the fields, rotation of crops, regulation of drainage, application of lime or fertilizers to the soil, propagation of disease-free stocks, seeds and setts or along such direct control measures as seed dressings and spraying (or dusting) of fields and plantations with appropriate fungicides known at the time.

But the discovery of the therapeutic value of heat in the science of plant pathology and its successful application thereto was made by the Danish school-master and agriculturist, Jens Ludwig Jensen. Working with the 'late blight' disease (*Phytophthora infestans*) of potato Jensen (1882) found that none of the control measures known at the time was effective enough to check the rot caused by the disease. But he achieved at the same time a momentous success to be able to discover that the fungus of the 'late blight' disease lives in a dormant way within the body of the tuber itself and that the disease manifests itself in the progenies when such tubers are next used for sowing or sets in rots when kept in storage for future consumption. This finding of the occurrence of the 'germ' of the disease deep within the tissues of the tuber had far-reaching consequences on the next course of his investigation. It dictated to him that surface sterilization of potato tubers with dusts or fungicides would be of no avail as the fungicide could not get in to affect the 'germ' living inside. And this set him to think how the internal dormant 'germ' (*i.e.*, fungus) of the disease could be killed without impairing the vitality of the tuber.

Happily, it was known to him that (1) all organisms could be killed by heat and (2) this lethal temperature (*i.e.*, the temperature that kills an organism) varied according to the organism that was sought to be killed. So, acting on this principle he first determined the lethal or death point temperature for the 'late blight' fungus as well as that of the seed potato tubers and found that a temperature of 40° C would kill the fungus within the potato tubers while a higher degree of temperature was necessary to cause the loss of viability of the potato tuber. So here Jensen got a thing which could penetrate in and destroy the fungal germ without killing the tuber itself because, as stated earlier, this temperature was much lower than that which would cause death of the potato tubers. He therefore, treated the seed potatoes in water at 40° C for 4 hours; this completely killed the internal fungal germ without impairing the germinating capacity of the tubers. But, since continued soaking for such a period in hot water softened the tissues and made them susceptible to subsequent rotting he applied dry heat instead by suspending a water-tight cylinder containing the potatoes to be cured, in hot water raised to 42-56° C till the temperature inside the cylinder recorded 40° C for 4 hours. Seed tubers sown after this dry heat treatment gave rise to healthy offsprings but the latter's immunity was not assured as the 'late blight' fungus could and easily did spread in such a healthy cultivation through secondary infections from adjacent diseased plots. So, to avail full advantage of this method of blight control it becomes imperative that adjacent plots should contain no diseased plants and the cultivators in a said locality must act co-operatively together.

Because of the latter condition this method of combating potato blight was not adopted in any measurable scale beyond Denmark, the home of its origin. But it was soon thrown into the background by the then discovery in France a couple of years later of Bordeaux mixture, which proved so efficacious in controlling the potato blight disease by checking secondary spread of infection and which, moreover, did not call for that type of co-operation imperative for the success of the hot-water method. But to-day Jensen's method holds a special offer to be taken full advantage of by countries that have run short of copper, a cheap and invariable ingredient of Bordeaux mixture, due to the impact of war.

But the method evolved first for potato soon found a world-wide application for prevention of seed-borne diseases of cereals, and recently of other crops.

Earlier to the application of the hot-water method all efforts at controlling loose smut of cereals proved a failure; and the reason for this escaped detection so long. And this, too, was left to the investigation of Jensen to show that the loose smut fungus, as in the case of blight disease fungus of potato, was an internal parasite living in a dormant way within the body of the grain. So surface sterilization with any fungicide so long proved a total failure. Jensen, therefore, subjected loose smut infected cereals to hot water at 50-52° C for 10 minutes; the seeds then became completely free from smut 'germ'.

In later years the researches of Appel and Riehm

(1911) have proved the accuracy of Jensen's method. They have further shown that the process could be hastened by pre-soaking the seeds for a few hours in water at ordinary temperature before putting them in hot water.

Jensen's hot-water method, despite the difficulty in maintaining accurate temperature range when treating bulks, is still considered as the only successful measure against loose smut disease of wheat, oats and barley ; and moreover this principle is now being increasingly availed upon to disinfect seeds, setts, or any other plant parts that are used for vegetative propagation where the disease germ, fungus, bacterium or nematode, is carried within the body of the 'seed' and is therefore inaccessible by any other means.

Indigenous modification of Jensen's hot-water method have been devised by various workers to suit local conditions. In India Luthra and Sattar (1934) employed with equal effectiveness solar energy in place of hot-water. Here the seeds are first soaked in water at ordinary temperature (as suggested by Appel and Riehm) in a bright day from morning to noon (1 P.M.) and are then exposed in thin layers to the full action of the sun where in the plains of the Punjab the temperature reaches as high as 129° F or more in the summer. Mitra and Taslim (1936) could employ with success Luthra and Sattar's modified method under North Bihar conditions. Similarly Lamb (1933) is reported to have successfully disinfected cotton seeds attacked with bacterium (*Bacterium malvacearum*) by exposing them in an iron dish to the full action of the sun daily for a fortnight in the month of June under Nigerian conditions where the day temperature sores as high as 60° C. Successful results have also been reported by other workers ; Wager (1935) could control brown rot of tomato caused by *Phytophthora parasitica* by immersing the fruit for 1½ minutes in water at 60° C, while Ogilvie and Brain (1936) could cure rust in mint by subjecting the runners used for vegetative propagation for 10 minutes in water maintained at 105-115° F.

The *Helminthosporium* disease is known to cause a serious loss to rice cultivation. The causative *Helminthosporium* fungus lives on the glumes and on the surface and inside the tissues of the fused pericarp and seed-coat (Nisikado and Miyake, 1920). Whether on the surface or inside the tissues of the fused pericarp and seed-coat the fungus is shut off from the outside by the presence of the two tightly fitting glumes (Tisdale, 1922). Necessarily externally applied seed disinfectants will scarcely be able to get in and affect the pathogen. This is the reason which so long baffled all attempts to proper sterilization of seeds through externally applied fungicides. The seeds are now being treated as under hot-water method at 52° C for 8-10 minutes after pre-soaking in water at ordinary temperature for 8-12 hours. This gives absolute control of the primary infections, but since the disease spreads in the field through secondary infections a foliage spray in addition is called for to get absolute control.

Application To Control Virus Diseases

Jensen's hot-water method evolved for curing seed-borne diseases of plants has now found an application to kill the active principles of the virus disease that live within the body of the plant. So setts or cuttings obtained from virus infected plants are first cured of the virus germ by subjecting them to Jensen's hot-water method before planting. But the results achieved here have not been as uniform. While Miss Wilbrink (1923) claims to have destroyed the virus agent in Black Cheribon sugarcane setts by treating them in hot water at 52-55° C for 30 minutes, Brandes and Klaphaak (1923), working with C.C. 701 variety of sugarcane, came out to say that immersion at high temperatures (45-55° C) for shorter period or at low temperatures (42-48° C) for longer period (up to 96 hours) could not cure the setts of virus germs. Blodgett's investigations (1923) on leaf-roll and mosaic of potato also support Brandes and Klaphaak's contentions. But the extensive researches conducted by Kunkel (1936) on peach yellow viruses suggest that different virus has different lethal temperature and this needs to be separately studied and determined.

Application To Control Nematode Pests

The hot-water method, so successful against seed-borne diseases, is now being increasingly employed to control certain of the nematode pests where the worm perpetuates, as in the case of fungal and virus diseases, from one generation to the next by being carried within the body of the bulb or other vegetatively propagated parts.

Ramsbottom was the first to try in the year 1918 the hot-water method against the nematode pest (*Anguillulina dipsaci*) of narcissus bulb. A 3-hours' treatment in hot water at 110° F is now prescribed for complete elimination of the worms from within the body of the bulb without impairing in any way the germinating capacity of the latter.

Since then and especially from the early 'thirties of this century this aspect of the nematode pest control is being increasingly studied ; and encouraging results have been obtained by English and American authors on chrysanthemum, strawberry, violet, begonia, etc.

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MEDICINE AND PUBLIC HEALTH

ONION PASTE AS A DRESSING

According to *Medical News Letter* No. 38, issued by the United States Office of War Information, promising results with onion paste used as a dressing for infected wounds have been reported by Dr I. V. Toroptsev and Dr A. G. Filatova, of the Tomsk State University and the All-Union Institute of Experimental Medicine, U.S.S.R. The experiments with onion paste followed reports by Dr B. Tokin that the essential oils of onion, garlic and certain other strong-scented vegetables contain substances that kill bacteria, protozoa and even larger organisms. These substances, or phytoncides, have not yet been identified chemically, but are extremely volatile, so that the paste has to be made immediately before use. The preparation consists simply of grinding the peeled onions or a portion of it and then placing the paste into a glass dish with a diameter equal to that of the wound. This is applied so that the paste does not come in contact with the wound, which is exposed only to the onion vapour for ten minutes. Of 11 patients treated, seven had amputations of the arm, one of the thigh and three of the foot, and all the wounds showed distinct purulent inflammation before treatment. After the first phytoncide treatment, the doctors report, all the wounds without exception became rose-coloured and the patients no longer complained of pain. After the second treatment the purulence and odour subsided. After five days all the cases showed extensive soft epithelialization. The Soviet scientists feel that phytoncides have a place in the treatment of infected wounds along with synthetic preparations such as the sulpha drugs.

PROPOSED CHANGES IN THE MEDICAL CURRICULUM

It is becoming increasingly recognized throughout the world that prevention of disease and the promotion of positive health require more emphasis than mere provision of measures for curing sickness. We understand that the Health Survey and Development Committee has had under consideration the question of revising the medical curriculum so as to shed much of the unnecessary burden that is placed on the medical student and of improving the content of the subjects taught and the method of teaching, particularly for the purpose of giving a preventive bias to the outlook of the student. The proposed changes in the curriculum will, it is hoped, enable the doctor of the future to offer to the people of India both curative and preventive health service in an effective manner.

Other subjects considered by the Committee (which, with its sub-committees, held meetings between July 1 and 15) included the place of the indigenous systems of medicine and of homeopathy in the future programme of medical relief for the country, the health of the school population, the control of venereal diseases, prevention of small-pox, physical education, health education and publicity, the problem of nutrition and control of food adulteration.

Groups of members of the Committee will shortly undertake tours in the provinces of Delhi, the U.P., Bihar, Orissa, Bengal and the C.P. Industrial centres in Northern India will also be visited. These tours will complete the rapid survey of existing health conditions in British India by the Committee, that has been in progress for the last few months.

WORK OF THE INDIAN RESEARCH FUND ASSOCIATION FOR 1943

Report of the Scientific Advisory Board of the Indian Research Fund Association for the year 1943 contains an account of research work on various subjects carried out under the auspices of A.R.F.A. During the year under review, a good deal of work on the nutritive value of dehydrated vegetables has been conducted in the Association's Nutrition Research Laboratories, Coonoor, under Dr W. R. Aykroyd. Steam-blanched cabbage was found to lose vitamin C more rapidly on storage than cabbage blanched by dipping in boiling water. Loss of vitamin C in dehydrated vegetables prepared by the so-called "pre-cooking" method was more rapid than in vegetables prepared by other processes. The general conclusion arising out of a considerable amount of work on the vitamin C content of dehydrated vegetables is that these cannot be relied upon as antiscorbutics after a period of a few months' storage.

While carotene is somewhat more stable than vitamin C in dehydrated vegetables, very appreciable losses occur on storage. After 20 weeks' storage at 98°F, bitter gourd, cauliflower, carrot, pumpkin and

potato lost from 35 to 65 per cent of their original carotene content. Losses in the mineral content of dehydrated vegetables during reconstitution and cooking amounted to 60 per cent. While attending the United Nations Conference on Food and Agriculture in U. S. A., Dr Aykroyd collected considerable literature on the effect of dehydration on the nutritive value of vegetables and other foods, a subject which is being intensively studied in England, Canada, U. S. A. and Australia.

During the year investigations continued on sprays for killing adult mosquitoes, on larvicides and on various drugs considered to be useful in the treatment of malaria. Investigations on the best method of treatment for starvation cases were undertaken and most actively pursued.

Leprosy research included the continuation of observations on the results of different kinds of segregation and progress was also reported in work on a specific test for this disease. Advance was made in work directed towards the improvement of anti-plague vaccine. On the pharmacological side, progress was made in investigations to determine the value, if any, of indigenous drugs reported to be of use in certain diseases. A comprehensive and practical programme has been outlined for 1944-45.

INFLUENCE OF VITAMIN C ON BLOOD SUGAR AND BLOOD SUGAR CURVE

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BANERJEE (1944) showed (*i*) that the glycogen content of the liver is diminished in scorbutic guinea-pigs but is not increased in normal animals receiving injections of large doses of vitamn C, (*ii*) that the amounts of liver glycogen in scorbutic and partly de-pancreated animals are comparable, (*iii*) that the ascorbic acid content of the liver is diminished markedly in both sets of animals but is increased in both cases after injection of vitamin C, and (*iv*) that the injection of vitamin C to partly de-pancreated animals increases the glycogen content of their liver. He further showed that deficiency of vitamin C brings about glycosuria in guinea pigs which exhibit the diabetic type of glucose tolerance curve, and causes reduction of insulin in pancreas and that injection of vitamin C restores the normal metabolism of carbohydrates in scorbutic animals. He also showed that in vitamin C deficiency the islet tissue of the pancreas is greatly increased or hypertrophied. From these evidences he concluded that vitamin C is similar in action to insulin and that glycosuria in scurvy is due to diminution in insulin content of pancreas.

The conclusion that vitamin C is similar in action to insulin is not warranted by these evidences. Insulin has three distinctive functions in the body, *viz.*, it prevents gluco-neo-genesis, promotes glycogenesis in liver, and helps the oxidation of carbohydrates, as is evident from the rise of R. Q. to about 1.* If insulin is injected to normal persons or animals in high doses, there is a prompt fall of sugar in blood which is of course compensated subsequently to some extent by the liberation of adramalin causing increased glycogenolysis. Banerjee has not been able to show whether vitamin C produces any of these actions in normal animals; on the other hand, he has shown that it does not increase glycogen deposition in normal animals.

In scorbutic animals extravasation is noticed in almost every part of the body. Accordingly one is justified to assume that blood supply to glands would diminish, particularly in such organs as are provided with a rich meshwork of capillaries of which the walls become very fragile in scurvy. The islet tissue of the pancreas is provided with sinus-like capillaries of which the walls are expected to be still more fragile. If these walls give in during scurvy, as they actually do, there would be a deficiency of supply of precursors of insulin and of nutrition to the islet tissue so that its output of insulin would diminish. In consequence, the symptoms noticed by Banerjee in scorbutic animals would necessarily supervene, such as diminished glycogen content of liver, increased sugar content of blood and the diabetic type of blood sugar curve etc. The enlargement of the islet tissue is also expected from the deficiency of supply of precursors of insulin, as a similar enlargement, *viz.*, general hyperplasia, is also noticed in the case of thyroid when animals are deprived of I_2, particularly during embryonic and early post-natal life. It is thus clear that none of the evidences presented by Banerjee can lead to the conclusion that vitamin C

* The rise of R. Q. may be due either to an increase in oxidation of carbohydrate or to an increase in the conversion of sugar to fat or both. After insulin injection there is not only an increase of R. Q. (*i.e.* $\frac{CO_2 \text{ given out}}{O_2 \text{ consumed}}$), but also an increase in the total amount of CO_2 given out and of O_2 consumed. This shows that there is an increase in the oxidation of carbohydrates.

is associated with carbohydrate metabolism or is similar in action to insulin.

To ascertain whether vitamin C has any role in carbohydrate metabolism it becomes necessary to find out how it affects blood sugar curve of normal persons if it is ingested sometime before, or simultaneously with, the intake of dextrose by subjects under experiment and what relationship exists between this modified blood sugar curve and that obtained after the administration of the second dose of dextrose to experimented subjects immediately after the return of the blood sugar to normal following upon their ingestion of the first dose of dextrose. It is known that the ingestion of a large amount of dextrose stimulates the production of insulin, so that after the intake by a normal person of a large quantity of dextrose which causes rapid and considerable fluctuations in his blood sugar level, he takes in again, within a definite period of time, another dose of dextrose, and the consequent fluctuations in his blood sugar level are much less marked than before. It may be argued that if vitamin C has an insulin-like action, it should prevent fluctuations in blood sugar level provided it be given before the first dose of dextrose, so that it may already attain that concentration in blood which might be necessary for it to cope with the rapid entry of dextrose therein after its ingestion. If, however, the rates of absorption of vitamin C and dextrose from the intestine are the same, the supposed action of vitamin C in preventing fluctuations of blood sugar level would be obtained if they (*i.e.*, vitamin C and dextrose) are given simultaneously.

In view of these considerations the following experiments were performed at the preliminary stage on 3 healthy students, *viz.*, H. R., R. R., and K. S. M. After fasting for 12 hours, their blood was collected for estimation of sugar* and they were given 75g of dextrose. After every ½ an hour up to 2 hours their blood was examined for sugar. At the end of 2 hours they were given a second dose of sugar and their sugar content of blood was again examined after ½ an hour to 40 minutes and after 2 hours. On the day following this experiment each of these students after again a period of fast for 12 hours was examined for his blood sugar (*i.e.*, fasting level of sugar) and then given 300 to 500 mg. of vitamin C. After ½ an hour their blood was collected for sugar estimation and then immediately given a dose of 75g of dextrose. Their blood was henceforth examined for sugar every ½ an hour up to 2 hours or more. The results of these estimations are given in Tables I, II and III.

* The estimation of blood sugar in all these experiments was made by the well-known method of Hagedorn and Jensen.

TABLE I

Showing changes in the percentage of dextrose in mg. in the blood of H. R. after 12 hours' fast due to the intake of 75 g. dextrose in 2 doses, the 2nd dose being given 2 hours after the 1st dose, and also due to the intake of vitamin C (300 mg.) followed after ½ an hour by the intake of 75 g. dextrose.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C, followed after ½ an hour by 75 g. dextrose	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	108	After 12 hours' fast	108
½ an hour after the intake of the 1st dose of 75 g. dextrose	174	½ an hour after the intake of 300 mg. vit. C and just previous to the ingestion of 75 g. dextrose	96
1 hour after „ „	148	1 hour after the intake of vit. C (*i.e.* ½ hr. after the intake of dextrose)	110
1½ „ „ „ „	137	1½ hrs. „ „ „	121
2 „ „ „ „	128	2 „ „ „ „	103
40 mins. after the intake of the 2nd dose of 75 g. dextrose	155	2½ „ „ „ „	108
2 hours „ „ „	119	3 „ „ „ „	92

TABLE II

Showing changes in the percentage of dextrose in mg. in the blood of R. R. after 12 hours' fast due to the intake of 75 g. of dextrose in 2 doses as in Table I, and also due to the intake of vit. c. (500 mg.) and 75 gm. of dextrose simultaneously.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C & 75 gm. of dextrose simultaneously.	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	84	After 12 hours' fast	93
½ an hour after the intake of the 1st dose of 75 g. dextrose	125	½ an hour after the intake of 500 mg. of vit. C and 75 g. dextrose simultaneously	141
1 hour „ „ „	150	1 hour „ „ „	104
1½ „ „ „ „	84	1½ „ „ „ „	98
2 „ „ „ „	76	2 „ „ „ „	108
½ an hour after the intake of the 2nd dose of 75 g. dextrose	79		
1 hour „ „ „	95		
1½ „ „ „ „	77		

TABLE III

Showing changes in the percentage of dextrose in mg. in the blood of K. S. M. after 12 hours' fast due to the intake of 75 g. of dextrose in 2 doses as in Table I, and also due to the intake of vitamin C (300 mg.) and after ½ an hour 75 g. dextrose.

Changes in dextrose content of blood after 2 doses of dextrose.		Changes in dextrose content of blood after a dose of vitamin C followed ½ an hour after by 75 g. of dextrose	
Time of examination of blood	Percentage of sugar in blood in mg.	Time of examination of blood	Percentage of sugar in blood in mg.
After 12 hours' fast	107	After 12 hours' fast	140*
½ an hour after the intake of the 1st dose of 75 g. dextrose	177	½ an hour after the intake of 300 mg. vit. C and just previous to the ingestion of 75 g. dextrose.	136
1 hour " " "	132		
1½ " " " "	138		
2 " " " "	134		
40 mins. after the intake of the 2nd dose of 75 g. dextrose	150	1 hour after the intake of vit. C (*i.e.* ½ an hour after the intake of dextrose)	142
2 hours " " "	112	1½ hrs. " " "	129
		2 " " " "	118
		2½ " " " "	115

It will be observed that after the 2nd dose of sugar the rise of blood sugar in all these cases has been distinctly less than after the 1st dose. This was expected. If vitamin C be ingested half-an-hour before sugar (*vide* Tables I and III), thus allowing it to be absorbed before sugar begins to enter blood in large amounts, the rise of percentage of blood sugar is markedly less than after the ingestion of the 1st dose of sugar alone, and may even be less than after the ingestion of the 2nd dose of sugar. If, however, vitamin C be ingested along with sugar and even in greater amounts, the rise of blood sugar is distinctly greater than when vitamin C is ingested even in smaller amounts half-an-hour before sugar, but the level of blood sugar is brought down quickly (*vide* the percentage of blood-sugar occurring one hour after the ingestion of dextrose alone and one hour after the ingestion of sugar and vitamin C in Table II). It is to be noted that while vitamin C prevents the abrupt rise of blood-sugar caused by the ingestion of glucose, particularly if the vitamin be taken sometime before glucose there may be a subsidiary small rise of blood-sugar after it has definitely begun to fall (*vide* Tables I and II). This is probably due to the rapid excretion of vitamin C from blood through urine and sweat. This, of course, requires confirmation by estimating vitamin C in blood simultaneously with sugar, so that the exact relationship between vitamin C content and the sugar content of blood may be ascertained.

Several problems emerge out of these experimental results. First, how does vitamin C prevent the abrupt rise of blood-sugar after its ingestion? If it be solely through the liberation of insulin, then the subsidiary rise cannot be explained. Secondly, if it has any direct action, then the R. Q., liver glycogen and the N_2 excretion through urine require to be studied, for these will show whether its action is similar to that of insulin, *i.e.*, vitamin C may also cause disappearance of sugar of blood by increasing oxidation and glycogenesis and reducing gluconeogenesis in which case N_2 excretion through urine will diminish. Experiments are in progress in the laboratory to record further observations about these interesting results, to find out the mode of action of the vitamin and to assess the vitamin C requirement of humans in view of these observations. These observations have opened up a vista of possibilities with regard to the treatment of diabetes.

* The subject had a fasting level of 107 mg.% blood sugar on the previous day. This marked increase in the percentage of the fasting level of blood sugar to 140 mg. on the following day raised suspicion regarding his fast for 12 hours previous to the collection of blood in the morning for estimation of sugar, but on enquiry it was learnt that the subject had very great worry and anxiety on the previous night in so much that he practically passed it sleeplessly. That extreme worry and anxiety cause a marked rise in blood sugar due to liberation of adrenaline is well-known and the present observation amply confirms this fact.

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BOOK REVIEWS

The Living Soil.—By E. B. Balfour. Faber and Faber Ltd. *12s. 6d.* net.

Adequately to review a book of this calibre is a task of no small responsibility. In the first place the volume comprises some 250 pages of closely printed matter, every paragraph packed with carefully reasoned discussion. Its theme has furnished occasion for a full dress debate in the House of Lords. Superficially it is concerned with the relative merits of organic and mineral fertilisers. Fundamentally the discussion involves the future, in the first place of England, and ultimately of world civilization, since life itself depends on the maintenance of soil fertility. The care and competence with which the subject is presented has caused one reviewer to describe the book as among the greatest achievements of women in modern science.

The trouble with regard to discussions on soil fertility, as in so many other regions of debate, has been false simplification, at any rate over-simplification. In the case of agriculture it is necessary to consider the great influence of Liebig who as long ago as 1840 emphasised the essentially chemical nature of crop production. The simplification here was the belief that by returning to the soil the chemical elements found to be present in the ash of growing plants the necessary balance of intake and output was maintained. Even in regard to possible fermentative changes taking place in the organic matter present in the soil, or added to it in manure, Liebig's explanation was still essentially physico-chemical rather than biological. His great influence dominated agricultural research for many years being evident at the great Rothamsted Experimental Station founded by the benefactions of Lawes & Gilbert, themselves supporters of the Liebig school of thought. Later the bacteriologist came into the field particularly in regard to the nitrogen cycle, the biological origin of nitrogen fixation and of the nitrification of ammoniacal products being clearly shown to be due to the activity of specific bacteria. It appeared simple therefore to add the necessary mineral constituents of plant food to the soil, sulphate of ammonia in particular, or nitrate of soda, taking a prominent place. So much was this the case that, as is well known, Sir William Crookes in 1898 gave out the warning of a possible nitrogen famine and stressed the growing need for nitrogen conservation. Largely in response to this, modern methods for nitrogen recovery from the air have been developed and quite recently India's need for a nitrogen recovery industry has been strongly emphasised and already preparations are being made for its establishment. Nevertheless the error or oversimplification is still present.

As the title of the book under review implies, the soil is not simply a mineral storehouse, but a world of living inhabitants each pursuing its specific vocation, and to a large extent mutually interdependent, and whose proper functioning may easily be upset by uninformed interference on the part of "exploiters" of the soil. "Exploitation" means the avoidance of Nature's necessary "Law of Return" which was at any rate partially recognised by Liebig so far as purely mineral constituents of plant food were concerned.

The contents of the book under review comprise a close discussion of each stage in this far from simple life cycle, which may be summarised in the diagram given on page 103 and reproduced below:

Vegetable Animal & Human Waste | →Fungus etc. | →Soil→ | Plant→Food | →Animal→ Man

Among these stages special emphasis is laid on the most recently observed link in the chain, *viz.*, the *mycorrhizal association* of fungus and plant root. It is this relation which is largely at the basis of the claims made for the special value of *"Compost"* as against all forms of mineral or synthetic fertilisers. According to the mycorrhizal theory these types of fungi attach themselves to the finer roots of the plant and the hyphae actually find their way into the vascular stream of the plant in question and are there digested, thus affording protein food to the plant instead of the simplified inorganic compounds hitherto supposed chiefly to contribute its sustenance. Opposite page 68 are shown actual photo micrographs of root sections and various plant cells including those of tea. Both organism and digested hyphae are shown within the cell.

The direct evidence for the mycorrhizal activity is largely based on the researches of Dr Rayner (published in *Forestry*, 1939) who has investigated the action of these fungi on pine roots in Wareham Forest, Dorset.

The wider significance of these researches has been emphasised by Howard. With the assistance of Dr Rayner and others it has been found that a very large number of different types of plant exhibit this mycorrhizal association including such important crop plants as cotton, grapes, hops and sugarcane.

Besides the fungi taking part in this mycorrhizal association it has been shown that other types known

as *predacious fungi* play an active part in destroying pests such as eel worm. Reproductions of drawings are given on Plate XI showing the actual fungal mycelia enveloping the eel worm.

The undoubtedly beneficial effect of organic matter, particularly of *compost*, is believed to be due to the maintenance of fungal activity which it ensures. Against this contention it has been claimed that crops grown purely on mineral nutrients *e.g.*, in water culture, the so-called 'hydroponic' processes, are as prolific and healthy as those grown under normal conditions. It is here that the crux of the discussion is located. The supporters of what may be termed shortly organics *vs.* minerals say that the question cannot be decided simply on quantitative results, that while *e.g.*, it is possible to increase the normal yield of rice by the application of minerals, it may be found on the other hand that a corresponding increase on the normal amount is required to satisfy the appetite of the consumer.

Moreover the more subtle attribute of *quality* comes into the discussion. Thus a case is mentioned where during a seasonal glut a van load of humus grown cabbages, obviously of special quality, was easily disposed of, while the unsaleable offerings sent on the same day by other growers to the same market were ultimately consigned to the compost heap.

Beyond the comparatively simple question of the satisfaction of appetite and possibly of aesthetic sense is the even more important if debatable factor *viz.*, the effect of the method of culture of food crops on *disease resistance*, both of the crop itself and of the animals or men by whom it is consumed. Evidence is brought forward to show that prolonged sustenance on food raised largely on mineral fertilisers, and at any rate on food which has been "processed" during its journey from the soil to the consumer, results ultimately in decrease of positive health, if not in the production of definite disease.

In addition to all these important matters for discussion is the physical effect on the *soil itself* of any disturbance in the right relations of its living population. Apart from fungal and bacterial activity it is well known that *worms* are very sensitive to change in alkalinity or acidity, and excessive treatment with mineral fertilisers tends to reduce if not to eliminate the worm population. The results of worm activity were long ago shown in Darwin's classical volume in which he describes most graphically the industry of worms not only in loosening up the soil, but in devouring and digesting fallen leaves and cellulosic matter and finally ejecting worm casts held together by excretory protein matter. The effect of worms both in increasing the porosity of the soil, and at the same time producing a satisfactory water retentivity, can hardly be exaggerated. Remarkable statistical data are given in the book. Thus it is stated that as many as eight million earthworms may be found in a single acre and that their burrows are capable of penetrating the subsoil to a depth of five or six feet.

If the actual nature of the soil is to be impaired or destroyed the results must be *erosion* and lamentable figures are given showing that modern methods —not of agriculture, but of "exploitation" of the soil—have destroyed more soil since 1914 than in many centuries.

It is clear therefore that unless the whole question is ruthlessly taken in hand and impartially investigated many apparently admirable plans for food production and social welfare may go sadly awry. The layer of fertile soil which holds the line between civilization and its final destruction is desperately thin.

The lines of the old water courses of "Nineveh & Tyre" are still visible from the aeroplane speeding over the deserts of Mesopotamia. The cheap food of the "Industrial Revolution" is ultimately paid for by the "dust-bowls" of Western North America.

The whole question is of such importance that as already mentioned it has been discussed at some length by knowledgeable speakers in the House of Lords, and at the present time a long term investigation has been set on foot in what is known as the Haughley Experiment.

In this Experiment to be carried out at the Haughley Research Farm in Suffolk, 200 acres are available of which 94 are devoted to what may be termed *humus farming*, organic fertilisers being used, and 88 acres to the equivalent use of mineral fertilisers. The Research Farm with its attendant buildings and laboratories is under the control of the Haughley Research Trust, with Lady Eve Balfour as farm manager.

Ten years of continuous work are planned watching the food cycle from man and animal through plant and soil back once more to animal and man. As a result it is hoped that the following five propositions, arising from the researches and observations discussed in the book, particularly those of Sir Robert McCarrison and Sir Albert Howard may be definitely answered:—

1. The primary factor in health or the lack of it is nutrition.
2. Fresh unprocessed natural whole foods have the greatest nutritive value.
3. Fresh foods are more health promoting than preserved foods.
4. The nutritive value of food is vitally affected by the way in which it is grown.

5. An essential link in the nutrition cycle is provided by the activities of soil fungi and for this and other reasons the biological aspects of soil fertility are more important than the chemical.

Already satisfactory preliminary work has been carried through, concerned particularly with the bringing into order of the two areas of land, so that the conditions of experiment may be strictly comparative. If as a result of this experiment there should be a general return to humus farming another health problem will soon be on the way to a solution, *viz.*, the economic and healthful disposal of towns' wastes both water-borne sewage and what is generally known as dry or dust bin refuse, or as "katchra" in India.

There is a temptation to enter into greater detail than is possible in a review. It must be sufficient to emphasise that no statement is made in the course of the lengthy discussions occupying with descriptions and illustrations nine chapters and a postscript which is not fully substantiated by carefully documented presumptive evidence, incomplete though some of it may be, and subject to further investigation at Haughley and other centres. There are twelve full or double page plates reproducing photographs of field or pot experiments or of microsections of plant tissue, twelve figures and diagrams illustrating compost making, Haughley Research Farm arrangements, statistical diagrams, etc. Ample and detailed technical references are supplied together with a bibliography and what is very welcome in a scientific discussion intended to be read by laymen or nonspecialists a *Glossary* of the special scientific terms used in the course of the presentation.

The book should be available not only in the library of every agricultural college but in every free library where it can be studied by intelligent and public spirited general readers. For it is more than a specialist discourse, it is a call to the service of humanity.

G. J. F.

'Nutrition'—By Dr W. R. Aykroyd. Published by the Oxford University Press in the series 'Oxford Pamphlets on Indian Affairs', May, 1944.

No subject is more to the fore today than nutrition. 'Through diet a new level of health can be attained, enabling mankind to develop its capacities to the fullest extent.' The correlation between quality of diet and health and physique has been beautifully brought out in the famous experiments of McCarrison at Coonoor. McCarrison's results show that the marked differences in the physique of the people of the different provinces in India were mainly due to the differences in their diets. Faulty diet is the cause of deficiency diseases in people and of much ill health not sufficiently severe to be classed as disease. Food will occupy a key position in postwar reconstruction. It is essential, therefore, that all the relevant facts should be assembled in good time to put before the public and legislators. A hearty welcome should therefore, be given to Dr Aykroyd's latest book, 'Nutrition', a recent addition to 'Oxford Pamphlets on Indian Affairs'.

After a brief introduction the author gives a short discussion of the dietary requirements of man and only refers to the accepted standards drawn up by authoritative organizations like the Technical Commission on Nutrition of the League of Nations and the National Research Council of America. Dr Aykroyd does not mention the actual amounts of different food constituents recommended for different age groups as also the special dietary needs of different classes. The reviewer would have welcomed a short discussion of this point. Dr Aykroyd summarises the recommendations in the following words, 'In terms of actual foods, this means a high intake of milk and milk products, meat, fish, vegetables and fruit and a relatively low intake of cereals.'

Then follows a survey of the food situation in India. Two well-known and distinct methods are used to estimate the nutrients available per head. On the one hand the amounts of food grown within the country plus the amounts imported enable a calculation of the nutrients theoretically available per head of the nation. The degree of reliability of the results of this method depends on the precision of the knowledge of the amounts of food produced in the country and also of the amounts of food in the country at any time. The second means of gauging continuously the national nutrition is the method of the domestic diet surveys which indicate the food consumed per head of the family. The figures from the diet surveys show broadly the effectiveness of food distribution.

In considering the food production data in India the Gregory Committee in its admirable report had pointed out that the data on the production of food was imperfect and Dr Aykroyd also is fully conscious about it. It has been pointed out in the Gregory report and also by Dr Aykroyd that none of the Indian States, which comprise some 47 per cent of the total land area in India, publish any production figures. While area statistics are fairly reliable, the same cannot be said about the standard normal yield per acre and the condition factor, all of which together determine the figures about annual yield. Ultimately all production statistics in India are based on information supplied by the village chowkidar unlikely to aim at scientific accuracy. Every one will agree with Dr Aykroyd when he says, "Caution is, therefore, necessary in using such statistics for any but the roughest estimates. Accurate statistics

are the life-blood of government ; in their absence all planning for the future is handicapped. Improvement in methods of collecting food production data is of essental importance to India." Available figures for the production of various crops like rice, wheat, millets, barley, maize, milk and milk products, nut and oil-seeds, fruits and vegetables, meat, fish, eggs and sugar are given. The total annual yield of cereals, millets, barley and similar grains is estimated to be about 60 million tons of which rice contributes about 28 million tons and wheat about 10 million tons. The total quantity of cereal grains at present produced in India is barley sufficient for the human population. When the requirements for seeds and for cattle and poultry are taken into consideration which Dr Aykroyd does not, the existing production of cereals will not cover requirements. The production of all other items is, as is pointed out by Dr Aykroyd, hopelessly inadequate. 'Imports and exports of food in normal times were small in relation to indigenous food production', says Dr Aykroyd. The only important import of food was Burma rice, supplemented to a small extent by rice from Thailand and Indo-China, amounting to some 4-5 per cent of the total rice supply. "It is quite clear that at present there is no margin of safety for the bulk of the population. 'Agricultural and import statistics', the author points out, 'indicate in a general way the nature of the Indian diet. They show that the main food of the country is cereal grains and that other foods are produced in relatively small amounts. They show that the per capita production of milk is small. Even a rough scrutiny of the food supply justifies the deduction that the national diet is defective in quality and does not conform to standards generally accepted by nutrition workers. Although Dr Aykroyd is not quite certain, the reviewer is definite that quantitatively also the food is insufficient.

The conclusions about under—and mal-nutrition among the people of India from production and import data are fully corroborated by 100 diet surveys carried out so far in different parts of India. 'In a diet survey a sample of the population is selected and the quantity of all foods consumed by each family over a given period is weighed by trained investigtaors who make daily house to house visits.' A considerable margin of error is inevitable in analysing the results of dietary surveys. Such surveys however, are the best available means of getting information on the highly important question of the extent to which people of the different classes and in different parts of the country are under-nourished. A brief description is given of diets based either on rice, wheat, millet or tapioca and we shall give Dr Aykrod's conclusions in his own words. 'Some of the groups included in the surveys were grossly under-fed. * * * Can we venture any tentative estimate of the proportion of the population which is under-fed in normal times? The author's estimate is 30 per cent (the reviewer would put it higher). * * * But, by and large, there is no doubt that a high percentage of the population does not get enough to eat.' Deficiency of fat, calcium and vitamins A, B complex, C and D are the main defects of Indian diets.

Vital statistics and the incidence of deficiency diseases and other manifestations of malnutrition are discussed later in the pamphlet but the reviewer is of opinion that a discussion of this should have followed immediately as this also supplies information on the existence and extent of under- and mal-nutrition. The infant, maternal and general mortality rates in India are high and are the direct effects of faulty and insufficient diet. It is pointed out that a number of well-known vitamin and mineral deficiency diseases are found in India.

In a discussion of the economics of diet Dr Aykroyd points out that in India as in other countries, increase in income leads to an improvement of diet in the right direction. He, therefore, pleads that a rise in the national per capita income will per se tend to improve standards of nutrition. The reviewer would ask, if that is possible without industrialization.

The rapid increase in the population in India and its bearing on the nutrition problem is very ably discussed. The pessimists are of opinion that efforts to improve the diet of the Indian people are futile as the maximum possible increase in the production of food will not keep pace with the growth of population and that public health measures will precipitate the crisis of over-population. On the other hand it is pointed out that utilisation of culturable waste, development of irrigation and land reclamation schemes and steady revolution in agricultural methods leading to increased yields can enable food supply to keep pace with or outstrip population growth. The ability of the country to maintain an optimum population depends upon its agricultural, as well as commercial and industrial wealth. The Malthusian thesis has been completely falsified and England is faced with a rapid fall in population. It is pointed out by Dr Aykroyd that the well-to-do in India are having fewer children and probably the process would spread to lower-income groups.

Having defined the problem Dr Aykroyd proceeds to give his suggestions with regard to its solution. Spread of knowledge of nutrition throughout the whole community is mentioned as the first requisite. The application of scientific planning to the nation's food calls for a better understanding by the public of the elementary principles of nutrition. Administrators, doctors, public health workers,

school-teachers and children—all these and many others must learn about nutrition.

Need for paying special attention to the nutrition of 'vulnerable groups' which include expectant and nursing mothers, infants, pre-school and school-children is then rightly stressed. If the available supply of milk is insufficient for the entire population, they should, the reviewer feels, have priority over others. The organization of school-feeding schemes is recommended.

Dr Aykroyd then insists that agricultural policy must be planned to correct the deficiencies in the diet of the population. The cereal production should, according to him, go up by 15-20%, pulse production by 15-25%, sugar production by 10-20%, milk, vegetable and fish production by 100%. The reviewer feels that our objective should be the provision of an optimum diet for all, irrespective of income, and plans should be laid to reach the objective by forced march, stage by stage, within a specified period of time. One would have welcomed a reference to the need for fertilisers, better seeds, better irrigation, crop-rotation and prevention of soil erosion. The reviewer does not agree that large-scale development of poultry-farming in India scarcely seems a feasible proposition.

One would have welcomed a reference to the need for the production of synthetic vitamins and vitamin concentrates on a large scale. Vitamin deficiency states of various kind and degree are common in India and unquestionably large sections of the population would be benefited in health by taking synthetic vitamins. The administration of vitamins can be combined with that of minerals like calcium and iron.

The processing of perishable foodstuffs during local and seasonal gluts facilitates their storage and distribution and helps to maintain an even flow and price throughout the year. One had expected a paragraph about the need of a well-developed food industry producing a variety of processed foods.

Proper distribution of foodstuffs is as important as production. One, therefore, misses a reference to this, as well as to the importance of communal feeding. A rapid development of communal feeding is going on in Russia and in Great Britain. Catering for people in large groups is not only economical in food, fuel and man-power, but also provides a good opportunity of improving the nutritional status of those fed.

But these are small faults to find with a work that so ably reviews the nutritional situation in India. Dr Aykroyd has succeeded in producing some very readable pages and the pamphlet will be very valuable to all who wish to keep abreast with the problem of nutrition in India.

K. P. B.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

ALGAE IN THE CRETACEOUS OF THE NARBADA VALLEY

During the microscopic study of the Bagh limestones, with which the present author has been busy for some time past, an interesting suit of well-preserved fossil algae, has been discovered. The family Corallinaceae is represented by *Archaeolithothamnium* (Fig. 1), while, *Dissocladella, Indopolia* and *Orioporella* (?) represent the family Dasycladaceae.

As in South India[1] and Assam,[2] association of these families again in the Narbada Valley Cretaceous is to be noted with interest. While the present discovery of these fossil algae thus, makes an important addition to our knowledge of their distribution in space and time, it provides another line of evidence for determining the age of the Bagh Beds, from which the present author[3] has already described a rich invertebrate fauna.

A full account of these fossils will shortly be published elsewhere.

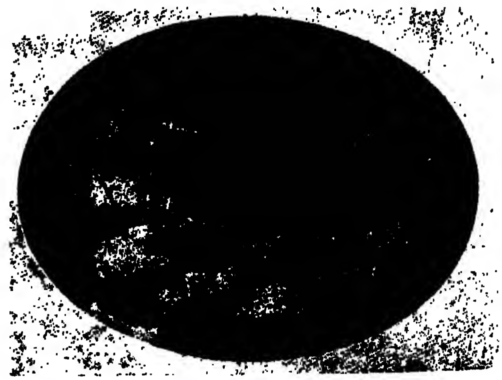

FIG. 1

The author is much thankful to Mr Rama Nagina Singh for his valuable help.

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Benares Hindu University,
Benares, 10-4-1944.

[1] Rama Rao, L. and J. Pia—*Pal. Ind.* (n.s.), *21*, *Mem.* 4, 1936.
[2] Sripada Rao, K.—*Proc. Nat. Acad. Sci.* (B), *13*, No. 5, 1943.
[3] Chiplonkar, G. W.—*Proc. Ind. Acad. Sci.* (B), *6-15*, 1937-42.

CHEMICAL INVESTIGATION OF *CYPERUS ROTANDUS* AND *CYPERUS SCARIOSUS*

Cyperus rotandus (N.O. Cyperaceae) grows abundant throughout India and Ceylon in moist soil. It is found in most other hot countries as well. Its vernacular names are Motha (Beng., Hind., Guj., Marathi)—Mustaka—(Sans.). The bulbous roots of the plants are used as a diphoratic, diuretic, and carminative agent. Along with other drugs it is recommended for dysentery. Rao and Hedji[1] isolated an essential oil from the plant. In our investigation besides the essential oil we have found an alkaloidal body giving positive tastes with Mayer's, Dragendorff's and Wagner's reagents. The base could not be crystallised but the following salts were prepared, hydrochloride m.p. 126°, picrate m.p. 170°, platinum chloride 110-112°. The alkaloid is a very weak base and is very susceptible to decomposition specially in alkaline media.

Cyperus scariosus known as Nagar Motha in Bengali, Hindi and Urdu is also widely used by Ayurvedic and Unani practitioners. We have detected an alkaloidal body giving positive tests with Dragendorff's, Wagner's and Mayer's reagents. We could only prepare a picrate, m.p. 102-103°. It is a very weak base.

However, we have obtained a volatile oil from this plant by steam distillation which differs considerably from that obtained from *Cyperus rotandus* in its physical and chemical constants. The oil has got a pleasant odour not unlike that from *Khas*.

We reproduce above the constants of the oil isolated by us from along with the constants of the oil from *C. rotandus* (Rao & others).

	Oil from	Yield	Density 30°	Ref. Index 30°	Optical rotation
I.	*C. scariosus* (distilled at Benares)	0·075%	·9876	1·495	nil*
II.	*C. scariosus* (at Kanauj)	0·080%	·9874	1·4892 to 1·4890	nil*
					α_D^{30}
I.	*C. rotandus* from Rhizome (Rao & others)	·65—·75	·9784 to 1·0009	1·5129 to 1·5132	23·0 to 35·5
II.	from roots (Rao & others)	·94	·9827	1·5117	11·2
III.	from tubes (Mysore) (Rao & others)	·45 to ·61	·9831 to ·9843	1·5055 to 1·5086	11·8 to 9·8

* No optical rotation could be detected in a 3% sol. in chloroform.

	Acid value	Ester value	Acetyl value
Cyperus scariosus			
I.	14·7	38·28	161·7
II.	12·5	39·48	156·4
Cyperus rotandus			
I.	1·1 to 11·3	4·9 to 20·1	63·3 to 84·0
II.	10·9	6·3	82·4
III.	8·1 to 10·11	4·8 to 8·9	87·4 to 100·8

The solution containing the acetylated oil (from Benares) after determination of its saponification value was rendered alkaline with sodium hydroxide and distilled in steam. The distillate was saturated with sodium chloride, extracted with ether and dehydrated over anhydrous magnesium sulphate. The dry oil thus obtained (d_{30} ·9918 ; $^{n}d_1$ 1·494) reacts with metallic sodium showing thereby the presence of free alcohol.

Further work is going on in the Department and would be published in due course elsewhere. The authors want to record their thanks to J. N. Kapoor, a third year student of this Department for distilling the oil first in the Department and then in his own works at Kanauj.

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Benares, 5-5-1944.

[1] Rao and Hedji, *J. S. C. I.*, *54*, 387-89, 1935.

"VENEZUELA GRASS"

In the *Statesman* of July 21, 1943, there appeared a short note from Shillong to the effect that the Agricultural Department, Assam, was "conducting experiments with a grass obtained from Venezuela* in S. America which, it is said, drives away mosquitoes, ticks and snakes and at the same time provides pasture for cattle." Neither the Department of Agriculture, Assam, nor the Imperial Council of Agricultural Research has so far given

the botanical name of the grass. From a note published in the *Indian Farming* for December, 1943 (pp. 632-633) it would appear that *in the absence of any other name* the grass has been named by the Assam Agricultural Department simply as "Venezuela grass".

Through the courtesy of the Assistant Fibre Expert, Bengal, this Department received a small quantity of the seed in August last. The grass raised from this seed flowered freely in our garden and we found it to be *Melinis minutiflora* Beauv.; this determination has since been confirmed by the authorities of the Royal Botanic Garden, Sibpur. The plant is a native of Tropical South America, Africa, and Madagascar and is known as "Molasses grass". It will be interesting to note that in Angola it is believed to be inimical to the dreaded tsetse fly, the bite of which causes sleeping sickness.[1,2] By virtue of its priority the popular name "Molasses grass" ought to replace the newly coined name "Venezuela grass".

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* The Secretary, Imperial Council of Agricultural Research, however, states that the seed was obtained from Jamaica.

[1] Bews, *The World's Grasses*, pp. 223-224, 1929

[2] Bailey, *The Standard Cyclopaedia of Horticulture*, p. 2026, 1935.

A NOTE ON ELECTROLYTIC INTERRUPTERS

Wehnelt[1, 2, 3] was the first to devise an electrolytic interrupter with a lead plate as cathode and the tip of a platinum wire as anode. Later on Caldwell and Simon in their modification replaced the platinum wire by another lead plate. We, under necessity, started with these known types and tried a number of other sets of electrodes of lead (L),* platinum (P), plated tin (T), carbon and copper etc. However, only the following pairs worked. (Table 1).

TABLE I

S.N.	Cathode	Anode	Remarks
1	L	P	(Wehnelt type). The platinum wire is soon burnt away.
2	L	L	(Caldwell & Simon type).
3	L	L with P	This is the most satisfactorily working type and most of the observations have been taken with this interrupter.
4	L	T	The length of the spark obtained with the T-electrodes is comparatively less but more intense than with the first three types. The working of the interrupter with the T-electrode is however, more satisfactory except for that (*i*) the T-electrodes are soon burnt away, forming probably stannic oxide, and the black residue falling down chokes the hole which is necessary for the production of the interruptions, (*ii*) some bad smelling gas, probably SO_2, is evolved with great rapidity and (*iii*) the noise produced is much louder. These defects render the use of the T-electrodes for an appreciable time, practically impossible.
5	L	T with P	
6	T	P	
7	T	T	
8	T	T with P	
9	T	L	
10	T	L with P	

The observations taken in the present case, most of which are visual and qualitative, indicate that the working of the electrolytic interrupter is governed by (*i*) the diameter of the glass tube enclosing the anode lead rod, (*ii*) the diameter of the hole, (*iii*) the length and the diameter of the platinum wire, (*iv*) the current, (*v*) the potential difference (P.D.) across the two electrodes, (*vi*) the temperature of the electrolyte and (*vii*) the concentration of the electrolyte. In the case of most of these factors it has been observed that there exist limiting lower and higher values below and above which the interrupter stops working altogether. Now practically all the other factors, excepting temperature and hence also the P.D. across the electrode (because the P.D. across the electrodes seems to be a function of the temperature of the electrolyte and goes on increasing with increase in the latter), can be given suitable working values at will. The temperature of the electrolyte (and hence the P.D. also), however, goes on increasing with time and finally, exceeding the upper working value, stops the working of the interrupter altogether within 20 to 30 minutes of its start. For a constant use of the interrupter for hours together, therefore, a cooling arrangement, which can maintain the temperature of the electrolyte to a maximum of about 50°C, is necessary.

Different current-values have got different satisfactory working ranges of the temperature and the P.D. The upper limiting values of the temperature and the P.D. are nearly the same for all the values of the current used; only the lower limiting values go on shifting to lower and lower values as the current is increased.

The most important factor is the diameter of the hole used. At a particular temperature a very small change in the value of the diameter of the hole brings about an enormously great change in the value of the P.D. which in its turn affects the working of the interrupter to an equally great extent. At a parti-

cular temperature and current, the P.D. across the electrode is very much higher but less steady with smaller than with bigger holes.

Other two points of importance that need mention are that (*i*) a hole, though not necessarily at the anode as suggested in the literature, is a necessity (there may be one hole at any one or both of the electrodes) and (*ii*) the platinum wire of the anode need not protrude through the hole; on the other hand, it is better to keep it centrally above the hole within about 2-5 mm. of it.

The exact mechanism of the working of the interrupter is not clear. It seems, however, that the interruptions are produced by the periodic sheathing and unsheathing of the hole by the gas bubbles produced during the working of the interrupter.

Details will be published elsewhere.

Our thanks are due to Prof. R. K. Asundi.

LALJI LAL

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3-8-1944.

* L-electrodes used were cylindrical lead rods.

[1] *Dictionary of Applied Physics*, 2, 1078-79, 1922.
[2] Electricity and Magnetism by S. G. Starling, p. 448, 1924.
[3] X-Rays by G. W. C. Kaye, pp. 66-onwards, 1926.

IONISATION IN ACTIVE NITROGEN

THE author of this note in two recent communications has put forward and substantiated the hypothesis that active nitrogen is simply the positive ions of nitrogen in the $N_2^+(X')$ state produced by the discharge.[1,2] The glow of the gas with its characteristic first positive bands was attributed to the excitation of the molecules by a three-body collision process as follows:

$$N_2^+(X') + e + N_2 \longrightarrow N_2 \text{ (B-state)} + N_2 \text{ (A-state)}.$$

According to the hypothesis, therefore, the ionisation and the glow are intimately associated. In the present note results of certain experiments on ionisation in active nitrogen as observed by Rayleigh and by Constantinides will be considered and it will be shown that while these receive easy explanation on the proposed hypothesis, their interpretations by any other theory lead to difficulties and contradictions.

The experimental results are the following:

(1) Ionisation is always associated with the glow; the decrease of the one is accompanied by the decrease of the other.[3]

(2) The glow and the ionsation persist even after the glowing gas from the discharge tube has been drawn through a pair of electrodes, with a strong electric field across them, with a view to "trap" any of the ions surviving from the discharge.[4]

(3) Ionisation current flowing between a pair of metallic electrodes immersed in active nitrogen is not the same for all metals; under similar conditions copper electrodes carry about six times as much of ionisation current as electrodes made of other metals.[5]

Experimental result (1) is an obvious consequence of the proposed hypothesis. Since the glow is caused by recombination of ions and electrons the intensity of the glow will diminish with the decrease of the concentration of the ions and electrons.

Experiment (2) is usually interpreted, on the assumption that the "trap" has removed all the ions and electrons coming from the discharge, as showing that the ionisation is produced by the active nitrogen. It is, however, not easy to envisage the mode of ion production. The only ways by which the ionisation can be produced are: (*a*) by the photo-electric action on the metal electrode by the light of the glow, (*b*) by photo-ionisation of molecules by same and (*c*) by energy imparted to N_2 molecules by active nitrogen. Experimental tests on (*a*) made by Rayleigh definitely exclude the possibility of photo-electric effect.[6] As regards (*b*) and (*c*) we note that the minimum ionisation potential of N_2 is 15·58 e.v. And, spectroscopic evidence show that extreme ultraviolet radiation of wavelength sufficiently small corresponding to this potential is not emitted by the glow. Spectroscopic evidence also show that the maximum energy which the active N_2 molecule can impart to another atom or molecule is only 9·5 e.v.[7] It is therefore clear that the ionisation cannot be produced by the glow. One is thus forced to the conclusion that the ion trap in experiment (3) is ineffective and that the ionisation in the glow is derived from the discharge. According to the proposed hypothesis this is possible as follows: We recall that according to the hypothesis the long life of active nitrogen is due to the reduction of the 'wall-effect'. This, in other words, means that only a small fraction of the electrons and ions proceeding towards the walls is able to contact the surface and recombine thereon with the glass acting as the catalyst. Now, the electrode surfaces of the ion-trap immersed in active nitrogen also become 'conditioned', at least partially, and, as such, prevent the access of the ions and the electrons on to them. The ions and electrons drawn from the discharge thus pass through the electrode system placed to trap them, and are present in the space beyond. In fact, the ionisation current flowing between such electrodes will only be a small fraction of that which would otherwise flow if the electrode surfaces were normal and unconditioned. It also follows that if the glow-

ing gas be drawn successively through two "traps", the ionisation current flowing between the second electrode system would be hardly affected if a field be applied across the first pair. This is what was observed in the experiment of Constantinides.[4] Two electrode systems, each consisting of a pair of coaxial cylinders were placed end on and the glowing gas from the discharge tube was drawn through them. It was found that the ionisation current between the second pair was decreased by only 2 per cent when a strong field was applied across the first, though the length of the first pair of electrodes was 1·4 times that of the second pair.

The fact that metal surfaces held in active nitrogen are conditioned is shown by experiments of Rayleigh on the incandescence of metals in it.[5] The metal piece becomes incandescent if it is not too far from the direct discharge or if it is slightly warmed. The interpretation of the experiment is that the metal is ordinarily unaffected because it is 'conditioned'. Only when the conditioning is destroyed by heating or by the surface being brought close to the discharge that reaction on its surface starts and the metal becomes incandescent by the heat of recombination of the electrons and ions.

Experimental result (3) is easily understood if the very natural assumption is made that different metals are "conditioned" to different degrees in active nitrogen. Indeed, it would have been surprising if it were otherwise. According to the explanation given above, electrodes made of metals which are conditioned to a lesser degree will carry comparatively large ionisation current. Such metals, because they permit electrons and ions to contact the surface, will also have comparatively greater destructive effect on active nitrogen. Experiments show that copper is destructive of active nitrogen to a greater degree than other metals;[9] electrodes made of copper therefore carry more ionisation current than those made of other metals.

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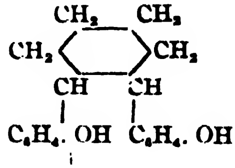
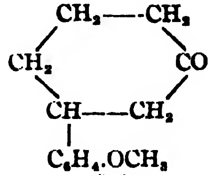
[1, 2] Mitra, S. K., Science and Culture, *9*, 49, 1943-44; *Nature*, *154*, Aug. 12, 1944.
[3] Rayleigh, *Proc. Roy. Soc., A.*, *86*, 56, 1911; *180*, 123, 1942.
[4] Constantinides, P. A., *Phys. Rev.*, *30*, 95, 1927.
[5, 6] Rayleigh, *Proc. Roy. Soc., A.*, *180*, 123, 140, 1942.
[7] Okubo, J. and Hamada, H., *Phil. Mag.*, *Ser.* 7, *5*, 372, 1928.
[8, 9] Rayleigh, *Proc. Roy. Soc., A.*, *178*, 1, 1940; *87*, 302, 1912, see also Ref. 3.

SYNTHESIS OF 1, 2-DI-P-HYDROXYPHENYL-CYCLOHEXANE.*

Recent developments in the field of synthetic oestrogens have stimulated renewed interest in the search for new substances of useful oestrus response having structures closely resembling that of 4, 4′-dihydroxy-α, β-dietheylstilbene and its hydrogenation product 4, 4′-dihydroxy-γ, δ-diphenylhexane. With this object in view, we have prepared 1, 2-di p-hydroxyphenyl-cyclo-hexane(I) by a method, which has been described below.


(I)


(II)

Potassium salt of ethyl p-methoxyphenylcyanoacetate was condensed with ethyl δ-iodovalerate, when diethyl-α-cyano-α-p-methoxyphenyl pimelate (b.p. 215-220°/6 mm.) was obtained in good yield. The cyanoester was hydrolysed by prolonged refluxing with concentrated hydrochloric acid and the resulting crude acidic product was esterified by the usual alcohol sulphuric acid method. Diethyl α-p-methoxyphenylpimelate (b.p. 206-208°/6 mm.), thus obtained, was cyclised by means of sodium dust in dry benzene, but as the cyclised product could not be distilled without decomposition, it was hydrolysed, without further purification, by refluxing with an excess of 20 per cent sulphuric acid. 2-p-Methoxyphenyl-cyclohexanone passed over as an oil on purification by distillation in vacuum and solidified on standing. (m.p. 92°, semicarbazone—m.p. 157°). Grignard reagent prepared from p-bromo-anisole and magnesium was reacted with the above ketone and the resulting crude carbinol was dehydrated by heating with fused potassium hydrogen sulphate at 180° to yield 1, 2-di-p-methoxyphenyl Δ^1-cyclohexene (b.p. 210-212°/5·5 mm.). 1, 2 Di-p-hydroxyphenyl-cyclohexane, which was obtained by catalytic hydrogenation of the above cyclohexene derivative followed by demethoxylation of the latter by refluxing with constant boiling hydrobromic acid in glacial acetic acid solution, melted at a range of 174-178° and seems to be stereochemically impure.

Further, we intended to prepare 1, 3-di-p-hydroxyphenyl cyclohexane by a similar method, using 3-p-methoxyphenylcyclohexanone (II) as the starting material. Previously there had been a claim for the synthesis of the latter by us.[1] But now we have found the compound prepared by us to be retaining an ethylenic linkage adjacent to the carbonyl group in the cyclohexane ring. It was observed during the repetition of these experiments that the

semicarbazone of the final ketone developed colouration on standing. Similar observation was already on record by Simonsen *et al*[2] in the case of the semicarbazone of synthetic cyperone, where similar groupings are present. Consequently this ketone was subjected to hydrogenation in presence of platinum oxide catalyst and was found to absorb one molecule of hydrogen and the resulting product yielded a semicarbazone (white) melting at 183-184° (shrinks at 180°) as different from that of the unsaturated ketone which melted at 217-219°. It is probable that the lactone of 1-carbethoxy-2-p-methoxyphenyl-2-hydroxypentane-5-carboxylic acid, which was treated with zinc and caustic alkali for furnishing the appropriate pimelic acid, had escaped reduction.

Further confirmation of the recent observation together with the details of works carried out with 3--p-methoxyphenyl-cyclohexanone will be published elsewhere.

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Calcutta, 7-8-1944.

* In view of the recent publications of the attempted synthesis of 1, 2-di-p-hydroxyphenyl cyclohexane by Price and Muller, (*J. Am. Chem. Soc.*, 66, 628, 632, 1944), we have placed on record the work carried out by us on the same.

[1] *J. Ind. Chem. Soc.*, 17, 573, 1940.
[2] *J. C. S.*, 1576, 1937.

A NEW SULPHAGUANIDINE

Recently considerable interests are being directed towards sulphaguanidine as it is being largely used in the treatment of bacilliary dysentery. The drug has, however, certain drawbacks—such as its higher dosage and comparative insolubility that prevents its parenteral use in urgent cases[1]

$$\left.\begin{array}{l} NH_2.\ C_6H_4\ SO_2.\ NH \\ NH_2.\ SO_2.\ C_6H_4.\ NH \end{array}\right\rangle C:NH$$

(I)

In search of some suitable sulphaguaridine derivative, we have obtained the compound—sulphanilyl-(*p*-sulphonamido-phenyl)-guanidine (I) by reacting sulphanilyl cyanamide[2] with p-amino-benzene-sulphonamide itself in molar proportions at a temperature of 180°C. The compound is readily soluble in dilute acid as well as in alkali. It crystallises from boiling water in slender needles, m.p. 215°. The activity of the compound is being studied *in vitro* against various dysentery organisms in presence of *p*-amino benzoic acid.

P. K. Das Gupta
P. Gupta

Bengal Immunity Research Laboratory,
Calcutta, 7-8-1944.

[1] Hughes, *Brit. Med. Jour.*, 1, 691, 1941.
[2] Winnek *et al*, *Jour. Amer. Chem. Soc.*, 64, 1682, 1942.

THE EFFECT OF HEAT TREATMENT ON THE K-ABSORPTION EDGE OF ZINC IN ZINC SULPHIDE

It is reported that zinc sulphide, when freshly prepared by the method of precipitation, is not luminescent ; but it becomes so after being heated at 900°C for half an hour. Differences of opinion exist as to the exact cause of the luminescence of zinc sulphide. Seit[1] interprets the blue luminiscence of this compound in terms of the interstitial zinc atoms, but this interpretation has been criticised by Randall[2] and others in several respects mainly because the existence of these atoms has not been demonstrated experimentally.

The effect of chemical binding on the X-ray absorption edge has been the subject of many investigations and it is now known that even the K-absorption edge of an element undergoes slight shift in the pure state and in compounds. The presence of interstitial zinc atoms in a sample of zinc sulphide (heated at 900°C) is, therefore, expected to affect the position and width of the K-absorption edges of zinc and sulphur in the zinc sulphide crystal and the effect on the K-absorption edge may throw some light on the question of these interstitial atoms.

In the present investigation, therefore, the K absorption spectra of zinc sulphide freshly prepared and heated at different temperatures have been photographed ; positions and widths of the absorption edge have been measured in each case with the purpose of studying the effect of interstitial atoms, if any, on the K-absorption edge.

The electron type of the metal X-ray tube fixed to a spectrograph as devised by Siegbahn has been used in the investigation. The slit through which X-rays enter the spectrograph is covered by an aluminium foil of thickness 0·009 cm. to separate the high vacuum side from the spectrograph. The well-known Bragg method is adopted for focussing with a calcite crystal. The distance between the centre of the crystal and the plate holder in this spectrograph is 17·5 cm., which gives a dispersion of about 16 X.U.

per mm. in the photographic plate in the region studied. The plane calcite crystal is rocked to and fro by an auxilliary motor through an angle of 1·5° both ways from the proper reflecting angle. An oxide coated 'dull emitter' has been used as the source of electrons.

For the absorption screen the samples were finely powdered and an emulsion of the powder in a gelatinous solution of celluloid in acetone prepared ; this emulsion poured on a clean glass surface evaporates into nice absorption screens. The optimum thickness could be obtained by a few trials. For heating the sample, electrical heaters made of nichrome wires were used. The temperature of the heater was measured with the help of a calibrated thermocouple and could be varied by adjusting the current in the circuit. During heating, proper precaution was always taken to prevent oxidation of the sample. The anticathode used was of copper ; the Cu $K\beta_1$ (1389 35X.U.) and the platinum $K\alpha_1$ (1310) could be taken as reference lines. Measurements were made on the microphotometer curves ; dispersion on the microphotometer record is 2·4X.U. per mm. The measurements are given in the table which is self-explanatory.

TABLE I

WAVE LENGTHS IN X.U.

	beginning of edge	position of edge	End of edge	Width	Shift Zn m
Zn. metal	1286·36	1275·75	1289·05	10·6	
ZnS at 30°C.	1289·94	1275·24	1282·54	14·7	2·49
ZnS heated to 500°C.	1289·42	1275·20	1282·31	14·22	2·26
ZnS heated to 590°C.	1289·03	1275·05	1282·18	13·98	2·13
ZnS heated to 1000°C.	1285·71	1275·6	1280·86	11·32	0·81
ZnO ..	1284·5	1279·1	1381·8	5·4	1·75

In discussing the results insufficiency of data is immediately apparent. The beginning of the absorption edge in metallic zinc is at 1286·36X.U. and the width is 10·6X.U. For samples of zinc sulphide at room temperature and heated to 500°C and 590°C it is found that the position, width and the beginning of the edge remain unchanged within experimental error. For the sample heated to 1000°C, these are no longer the same but suffer a change, and the change is in every respect towards those of the metallic zinc. These results may be taken at least qualitatively as an indication of the existence of some free zinc atoms in the lattice ; of course it must be admitted that further detailed investigations are necessary to settle the question finally.

Our thanks are due to late Prof. B. B. Ray, D.Sc., Khaira Prof. of Physics, Calcutta University for granting facilities of work in his laboratory.

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Calcutta, 7-8-1944.

[1] *Trans. Farad. Soc.*, p. 83, 1939.
[2] *Ibid.*, p. 85, 1939.

BALANCING OF CHEMICAL EQUATIONS

The above letter by Mr R. Parshad was published (SCIENCE AND CULTURE, 10, 95, 1944) through inadvertence, as such methods of balancing chemical equations are quite well-known and are found in many text books of chemistry. For instance, we may draw the attention of the author in this connection to the Textbook of Physical Chemistry by James Walker (1919 Edition).

Ed. SCIENCE & CULTURE

Calcutta, 7-8-1944.

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NEED FOR A CENTRAL BUREAU OF STANDARDS

THE subject of standardization, especially the development of the methods of standard specification of industrial and commercial products, has so far received scant attention in this country. At a time when plans for the creation of a number of central laboratories, such as the National Physical Laboratory, the National Chemical Laboratory, the National Metallurgical Laboratory, the Glass and Silicate Research Institute and the Central Fuel Research Station are being discussed and some are already in the process of being executed, it is curious that so little attention is being paid to the all-important question of specifications and maintenance of standards in this country. The establishment of these laboratories, we are given to understand, will provide the necessary scientific background needed for the post-war industrialization of India. But the efficiency of that process, it need hardly be added, requires simultaneous development of organizations for the specifications and maintenance of standard work which is now in a state of hopeless muddle and neglect. Varied and sometimes conflicting standards, not infrequently lacking proper scientific basis, are in use in India and have sometimes become even a retrograde factor in the healthy growth of industries and the smooth operation of commercial transactions. One clearly perceives the paramount need of standardization work in all fields of a country's activities—agricultural, industrial and commercial, and it is high time that the attention of the Government, the industry, scientists and experts concerned were focussed on this question. Elsewhere in this issue we publish an article to indicate more fully the scope of such standardization work and the ways in which such work is being conducted in other countries, notably the U. S. A., and the United Kingdom.

In India we have several purchasing agencies. Apart from the activities of the present Supply Department, which is purely a war emergency organization, the Indian Stores Department since 1921 been doing all the purchase and inspection of materials on behalf of the various civil departments and railways and has drawn up a number of specifications for various materials (I.S.D. specifications) in collaboration with the Government Test House, Alipore.

The Railways have got their own specifications called the Indian Railway Standard specifications (I. R. S.) to guide them in their purchases. The Railway Board has got a standardizing section called the Central Standard Offices and draws up the I. R. S. specifications through the agency of its committees in close collaboration with the Government Test House, Alipore, and the Indian Stores Department.

The Master General of Supplies has his own specifications (M. G. S. Specifications). The War Department follows the B. S. Specifications and the Air Ministry Material Specifications (D. T. D. specifications) in addition to its own specifications (I. M., T. and R. I. A. S. C. specifications). Other bodies like the Corporations, Municipalities, District and Local Boards, and Indian States adopt any one of the non-military specifications, particularly the I. S. D. specifications, according to their convenience.

The private consumer in many cases is ignorant of all these apparently confusing specifications and is content to be at the mercy of traders and their trade marks.

The present war has introduced further confusion and complications due to the dearth of proper materials, and the springing up of a host of war emergency specifications. Adulteration in foodstuffs is very commonly practised owing to utter lack of any control or standardization in these essential commodities.

As regards weights and measures, nowhere do we find so much confusion as we find in India, and

standardization and verification of local weights and measures constitute an urgent problem.

Some beginning in standardizing work has been made in certain fields. The Agricultural Department, through its Marketing Boards, has been doing useful work in the grading of commodities, such as, eggs, fruits, tobacco, oilseeds etc. agricultural dairy and poultry products bearing the "AGMARK" stamp are considered to be standardized goods. Some textile goods are now coming under standardization as a result of war conditions. There is a standardizing laboratory at the All India Institute of Hygiene for drugs standarization. The I. S. D. and the I. R. S. specifications have done some useful work by laying down standards for certain types of materials for the guidance of manufacturers and consumers. We may, however, add that Metallurgists and Chemists Sub-Committee of the I. R. C. A. has nothing to do with standardization and that the Paints Committee (N. 5 Standing Committee) of the C. G. I. is doing war emergency work of no permanent value.

Various Imperial Conferences have stressed the necessity of co-ordination within the Empire of the nationally agreed specifications, and the desirability of establishing one central national standardizing body in each of the commonwealth units. Most of the Dominions have already established their own standarization oragnizations. But India, which is the biggest unit in the British Empire has not so far attempted to establish its own central standardizing body capable of co-ordinating the huge mass of heterogeneous work that is going on in this subcontinent.

Some years back, we understand, the Government of India was actually negotiating to have a central standardizing body, similar to those established in the other units of the British Empire, but subsequently it was thought that the creation of a separate body for this specific purpose alone was not financially justified. It was hoped that in the near future a standardizing department could be established at least as an adjunct to an already existing Government Scientific Institution.

It has been the experience of those, engaged in the testing of materials against specifications, that the insistence on rigidly following foreign standard specifications, such as the B. S. Specifications, is not only unnecessary under Indian conditions but is sometimes detrimental to the free development of industries in this country. Numerous instances could be quoted in which the conditions of testing with regard to temperature, humidity, and other atmospheric conditions, and also the limits of chemical composition of the materials in relation to the particular raw materials used, require substantial modifications to suit Indian conditions. Certain raw materials, which otherwise would not have been utilized industrially have now been considered suitable as a result of investigations carried out in some of the existing Government laboratories.

The few engineering and technical institutions existing in India, such as the Institution of Engineers (India) and the Institution of Chemists (India), have not been developed to such an extent as to take up independently the work of standardization and drawing up of specification, as is being done by similar bodies in England and America.

At present there is no central organization in India to deal even with the B. S. Specifications as and when they are referred to India for suggestions and improvements. Sometimes they are circulated to a few institutions like the Government Test House, Alipore, and a few isolated experts in the country, through their local agency, the Institution of Engineers (India). The Institution of Engineers, as it is at present, is not expected to be very much interested in many of the specifications, referred to them and consequently no organized or substantial co-operation in the framing of these B. S. Specification is possible. The universities and technical and learned bodies in India do not appear to be interested either on these matters.

The present consciousness that is being roused in industrial research and allied matters in this country will, we hope, bring about a better appreciation of this important subject which is intimately connected with industrial progress.

Industrial research itself is of recent origin in India. The present war has given an incentive to speed up industrial research, due to the cutting off of supplies from foreign countries, and the consequent search for temporary substitutes.

The Council of Scientific and Industrial Research in India is an organization which is trying to organize its activities on the same lines as the Department of Scientific and Industrial Research (D. S. I. R.) of England. Under its auspices various laboratories are carrying out a large amount of industrial research work and it is now proposed to have a number of research institutions (previously mentioned), established in India.

The National Physical Laboratory which is expected to be established soon in one of the important scientific centres of India will, it is expected, be mostly concerned with industrial research in subjects similar to those dealt with by the National Physical Laboratory of England excepting some of the branches like metallurgy etc., which are to be specialized in separate institutions. But unless testing and standardization work is also included in

its principal activities or unless by scientific arrangement with the National Physical Laboratory it is concentrated in an existing institution, such as the Government Test House, Alipore, where testing, standardization, and specification works in limited fields are already being carried out, it will not have the same complexion or the same importance as the National Physical Laboratory of England, so far as industrial standardization work is concerned. Moreover, the proposed National Chemical Laboratory in India may be established at a different place and as such may not be an adjunct of the proposed National Physical Laboratory, as is the case with regard to the National Physical Laboratory and the Chemical Research Laboratory, both situated together at Teddington, and consequently, full standardization work, both physical and chemical, cannot be expected to be carried out efficiently in either one of these proposed individual laboratories ; the Government Test House, however, has facilities for both physical and chemical work.

In England, the British Standard Institution is there to collect data and co-ordinate the results obtained at various centres of work, and the National Physical Laboratory is the most important Government institution where standardising work is actually being carried out.

In India, where non-official technical institutions are poorly equipped for this kind of work, a combined institution where both these things could be done without running into heavy expenses is the most desirable at present.

This can be easily achieved if an existing institution like the Government Test House, Alipore, which has got experience in testing, standardizing and framing of specifications in a limited field, is pressed into service. This can be done either by actually establishing the proposed National Physical Laboratory at Alipore, or by making the standardization work exclusively a responsibility of the Government Test House.

It can expand its activities in the following ways :—

(1) To arrange for test programmes in connection with the drawing up of specifications.

(2) To carry out investigation and research work in order to standardize materials to suit particularly Indian conditions.

(3) To collect data and co-ordinate the work carried out at different places, and also to be in touch with the various technical institutions and learned societies in the country, and draw up specifications.

(4) To prepare chemical standards for use as standards and references in India. To maintain correct standards in weights, measures and instruments for standardizing apparatus used for measurement of heat, electricity, etc.

(5) To standardize methods of testing and analysis in order to ensure uniform results in various testing laboratories, and to develop new methods, whenever possible and necessary ; X-ray and spectroscopic analysis, flourescence method of testing, micro-chemical and semi-micro-methods, spray tests and other new methods for determining the efficiency of metallic coatings, spot tests, and a host of special methods and technique, which are being put to use in other countries, are to be developed here and standardized.

A Central Bureau of Standards of this type, if established in India, would be of immense help not only for the industrial development but also for the progress of industrial research in India.

STANDARDS AND THEIR SPECIFICATIONS

(Contributed)

IN ancient and medieval times, standards of quantities in every day use were in a state of utter confusion. Almost every State, nay every city, had its own standard of length and weight, and it is now one of the tasks of the antiquarian to find out the exact value of many of these ancient standards of length and weight. Thus the English standard yard is supposed to represent the measure of the distance between the tip of the nose and the end of the middle finger of the fully outstretched hand of some ancient English king, possibly Edward I. The first scientific attempt to put weights and measures on a scientific basis was made during the French Revolution, when the metric system was introduced and the Bureau des Poids et Mesures was established with the object of defining these standards, maintaining them, preparing secondary standards, and working out for the whole country a uniform system of weights and measures. Other countries followed in the wake of the French, some quickly, others more tardily.

Since the rise of the scientific age, hundreds of new measuring devices have been coming into operation, such as thermometers, electrical meters, gas and water meters etc. Hundreds of new commercial products are being put in the market, and they all require 'standard specification'.

What is 'Standardization'?

"Standardization means setting up standards by which extent, quantity, quality, value, performance and service may be gauged".* In all fields of a country's activities—agricultural, industrial and commercial—standardization is of paramount importance. Weights, measures, agricultural products, manufactured goods, building materials, hardware, fuels, paints, textiles, drugs, nay every article that passes through the hands of the producer, the seller and the consumer, need some sort of standardization. This standardization applies particularly to industrial and commercial products.

Tracing the development of standardization in England, we find that the beginning of industrial standards in that country was made by Sir Joseph Whitworth who in 1841 introduced his standards for screwthreads and plane metallic surfaces.

In 1895 one Mr H. T. Skelton, a London engineer and merchant, drew the attention of the public to the numerous variety of steel sections and the consequent loss to manufacturers and merchants through locked up capital in plant and unremunerative stocks.

In 1901 the Council of the Institution of Civil Engineers formed a committee of six to draft standard forms of iron and steel sections. This was the real beginning of the regular standardization work in engineering and industry in England.

Standardization work on industrial products mainly comprises the following:—

(1) Standardization of nomenclature and symbols.

(2) Simplification of types and sizes including standards set up to secure interchangeability of parts.

(3) Standardization of the quality of the materials.

(4) Setting up of standards for construction and workmanship.

(5) Standardization of machinery and apparatus for purposes of comparison.

(6) Standardization of methods of testing and analysis of materials.

(7) Preparation and maintenance of standards for reference work and comparison.

Products should be standardized so far as is consistent with progressive development of manufacturing and should be standardized to the fewest practical kinds, sizes and grades.

Advantages of Standardization

The various advantages derived from standardization need hardly be over-estimated. It stabilizes production and employment and reduces cost of production as well as the selling price (the latter is possible through the reduction in advertising expenses). Since the process of standardization is carried on in the light of the latest scientific development, it eliminates faulty practices depending on traditions and accidents, promotes general efficiency and acts as a powerful stimulus to research and development. It promotes fairness in competition and minimizes litigation. It develops healthy foreign trade and facilitates the work of purchasing agencies. The availability of ready standards for reference and comparison promotes industry and trade and makes possible a sympathetic co-operation between the manufacturer and the consumer not only in one's own country, but between country and country, through national and international standardizations adopted by mutual agreement. For a detailed account of the various advantages the reader may be referred to 'Encyclopaedia Britannica.'

What are Specifications?

The drawing up of specifications constitutes a very important part of the work of any standardizing organization. Standardization in its ideal form is generally undertaken at the request of industries, or by associations representing such industries in a country. But in places where these are not properly developed, the initiative is to be taken by the State itself. There should be sympathetic co-operation between the producer, the consumer, and the State in arriving at agreed standards. Physical properties, measurements, strength of materials, chemical composition, workmanship, details of inspection, tests etc. are stipulated in the form of a specification—laying down certain limits. Such nationally accepted specifications safeguard purchasers by ensuring a generally suitable quality and performance at a reasonable price. There should not be any coercion on the part of the framers of the specifications, and the initiative for producing better designs should not be curbed, and for this there should be periodical revisions of specifications by mutual agreement. A specification generally lays down the best acceptable performance observed in a particular product, arrived at by committees of persons who represent science, industry, business and also consumers.

Standardization concerns mostly with the fixing up of conditions for the best performance of a group of similar materials. It does not, however, aim at ideals, or the production of the best or the most costly material. The performance of any article and its requirements depend to a considerable extent upon the place, time and circumstances and conditions of its use. For instance, during war time, when articles are expected to give maximum available efficiency during a limited period and have often to be manufactured with unusual raw materials, the quality of

* 'Encyclopædia Britannica'.

the manufacture may be allowed to vary from those stipulated in ordinary specifications. In such cases we have what are called emergency specifications, adopted for the time being. Similarly, for different climates with different temperature and humidity conditions, particular specifications have to be modified. So also, in cases where different types of raw materials are available for manufacturing a certain product, there ought to be a variation in the specification to suit the raw materials.

Therefore, any specification framed for a particular product or commodity in a particular country may not always be found suitable for another country where conditions are different.

Industrial Standardization Organization

The work of an Industrial Standardization Organization can be broadly divided into the following sections:—

(1) Actual work on standardizing a product by studying the best performance of a group of similar articles. This involves a considerable amount of research and investigation work.

(2) Drawing up of specifications in consultation with manufacturers, businessmen and consumers.

(3) Maintenance of standards, *e.g.*, (*i*) precision instruments, for measurement of weight and volumes and for measurements of units of heat, electricity, light, magnetism etc. (*ii*) chemical standards, and standard samples of certain finished products for reference work.

(4) Standardization of the methods of testing and analysis.

(5) Co-operation in international standardization, for promotion of healthy international trade.

In all industrially and scientifically advanced countries, we find two sets of organizations working separately but co-operating with each other in standardization work.

The first set comprises the various technical and engineering Associations where membership is open to producers, businessmen, consumers, scientists etc., who are interested in the advancement of industries and industrial research. Their finances are mostly derived from subscriptions from members and industries, and from sale of publications.

These Associations co-operate with one another and form into a national body which is independent of Government, though enjoying its support. This body collects data, appoints committees, and issues specifications for the benefit of the public.

The second type comprises Government Departments where research and investigation work connected with scientific and industrial matters is carried out. Standardization work and certain research programmes connected with the framing of specifications are mostly carried out in these Government laboratories. The heads of these laboratories and institutions and other members of the staff are closely associated with and represented on the councils of the national organizations and collaborate with them in framing specifications.

The British Standard Institution in England and the American Society for Testing Materials (A.S.T.M.) are examples of the first type.

The National Physical Laboratory and Chemical Research Laboratory, Teddington (England) and the National Bureau of Standards, Washington (U.S.A.) are examples of the second type. Unlike the National Physical Laboratory and the Chemical Research Laboratory, Teddington, the National Bureau of Standards, Washington, frames specifications and commercial standards on behalf of the United States Government.

A brief account of the working of these standardizing institutions in Great Britain and in America will now appear in what follows.

Standardizing Institutions

There are about 21 National Standardizing bodies in the British Commonwealth and other foreign countries. The most outstanding organizations in the English-speaking countries are (1) the British Standards Institution, (2) The National Physical Laboratory, Teddington, (3) The Bureau of Standards of the Department of Commerce, U.S.A. and (4) The American Society for Testing Materials.

The British Standards Institution

The British Standards Institution is the National Standardizing Organization of the United Kingdom and it issues the British Standard Specifications (B. S. Specifications). It is an independent body in the closest touch with industrial requirements and modern technical knowledge, and enjoys the fullest Government support but is free from Government control. It co-operates with the Central Standardizing bodies in the various parts of the British Commonwealth of Nations, is in direct touch with the standardizing bodies in foreign countries, and participates directly or indirectly in the work of international standardization in industrial matters. It is a development of the Engineering Standards Committee, which was formed in 1901 by the joint action of the different Institutions of Engineers, and consisted of only eight members.* The British Standard Institution has now more than 700 different com-

* Out of this Committee was born the British Engineering Standards Association (B. E. S. A.) which was subsequently re-named the British Standards Institution. As the specifications issued by the organization cover engineering subjects (both chemical and physical), the change in designation was both appropriate and necessary.

mittees consisting of scientific men, businessmen, industrialists and consumers who give their time and experience freely. Many of the research laboratories and Associations work on certain subjects in close co-operation with this Institution, and in many cases the results of research thus obtained are expressed in the form of British Standard Specifications.

The Institution's funds are mostly derived from contributions from the various industries and sales of publications etc., but the British Government together with the Governments of the Dominions, India, and the Crown Colonies contributes liberally. Also the various Municipal Corporations and Technical Institutions in England subscribe to its funds.

It has four Divisional Councils, namely (1) Building Divisional Council, (2) Chemical Divisional Council, (3) Engineering Divisional Council, and (4) Textile Divisional Council. Each of these councils consist of members representing various interests, official and non-official.

Over these councils, there is a General Council consisting of Chairman, Vice-chairman and members. A certain number of these members are nominated by the following bodies:—

(1) The Board of Trade; (2) The Department of Scientific and Industrial Research; (3) The National Physical Laboratory; (4) The Institutions of Civil, Electrical and Mechanical Engineers; (5) The Federation of British Chamber of Commerce. The others are elected by the four Divisional Councils to represent their various branches. It appoints various sub-committees for different branches of industry and science, and prepares the B. S. Specifications. It undertakes periodical revisions of the specifications if and when necessary. It is also entrusted with the work of preparing what are called the 'British Chemical Standards' for use as standards in all chemical laboratories. From time to time a number of industries and Associations connected with various branches of engineering and industry have approached this Institution for help in their standardizing work, and it has attained a supreme position, as the highest standardizing organization in the whole of the British Empire.

The National Physical Laboratory, Teddington

The National Physical Laboratory at Teddington, near London, is the largest research laboratory in England in physical sciences. Adjacent to it is the Chemical Research Laboratory, supplementing the work done at the National Physical Laboratory in the field of chemical research and investigation of industrial problems. The National Physical Laboratory was founded in 1900, and subsequently incorporated in the Department of Scientific and Industrial Research in 1918 after the latter body came into existence.

Its functions are controlled by a number of committees *e.g.*,

(1) The Committee for Fundamental Research.

(2) The Electrical units and Standards Research Committee.

(3) The High Tension Research Committee.

(4) The Advisory Committee for Metallurgical and Engineering Research on Materials.

(5) The Advisory Committee for the William Froude Laboratory which is concerned with the investigation of ship design.

One of the purposes for which the National Physical Laboratory was founded was 'to establish and maintain precise standards of measurement'. Even now, out of the funds allotted to general research and the maintenance of standards, more goes to the maintenance of standards than to general research, thus emphasizing its original role as a standardizing institution. A large amount of research is carried out on behalf of the Department of Scientific and Industrial Research, and also for the benefit of the other Government departments and the public. A considerable amount of testing work also is carried out in this Laboratory.

The scientific work of the Laboratory is divided into eight departments, *e.g.*, Physics, Electricity, Radio, Meteorology, Engineering, Metallurgy, Aerodynamics, Ship design Laboratory—each of which is under the charge of a superintendent who enjoys a large amount of freedom in the selection of subjects for research. Most of the departments contain several divisions, each under the charge of a senior officer who in turn also enjoys a certain degree of autonomy in matters of research and investigation.

The National Physical Laboratory, in addition to carrying out research, co-operates very closely with standardizing institutions like the British Standards Institution. This Laboratory, though incorporated now in the D.S.I.R. of England and carrying out researches on its behalf, still maintains its original functions of testing and standardization, and is controlled to a large extent by members nominated by the Royal Society and various other learned and technical societies and institutions in England.

In the Chemical Research Laboratory which was opened in 1925, adjacent to the National Physical Laboratory, varied investigations connected with the chemical industry are carried out. Synthetic resins, paints, low temperature carbonization, high pressure chemical work, corrosion of metals, chemotherapy, water pollution are some of the subjects tackled in its various departments.

The National Bureau of Standards, U.S.A.

This was established in Washington, U.S.A. in 1901 by an Act of Congress. Its functions are according to the 'Encyclopaedia Britannica', 'the development, construction, custody and maintenance of reference and working standards, and their intercomparison, improvement, and application in science, engineering, industry and commerce'. The Bureau is a part of the Department of Commerce, U.S.A. Its services are available without charge to national and State Governments, and under certain conditions, tests and investigations are conducted for the public. It serves as a clearing house for scientific and technical information, and to this end co-operates with similar institutions abroad, and with research laboratories in America. In 1939 its regular staff consisted of 950 employees and 80 Research Associates.

Its work is broadly divided into two sections:—

(1) Scientific and technical research and testing.

(2) Establishment of commercial standards including building and housing specifications.

Each is made up of various divisions and sections, each section being the working unit dealing with some specific problems.

Electricity, weights, measures, heat and power, optics, chemistry, mechanics and sound, organic and fibrous materials, metallurgy, and ceramics are some of the important divisions in this organization. The organization and working of this institution is similar to that of the National Physical Laboratory but it appears to cover a greater field in matters of industrial research, testing and standardization than does the National Physical Laboratory.

In addition to this, there is another Standards Department in America called the Standard Weights and Measures Department. Its functions are the custody of the federal standards and verification of local standards, including gas measuring standards and flash point apparatus for petroleum.

The heads of the departments of these Government technical institutions are officially represented on the councils and committees of the various standardizing societies in America.

The American Society for Testing Materials (A. S. T. M.)

The American Society for Testing Materials was organized in 1898, and finally incorporated in 1902 as a national technical society. Its specific purpose is 'the promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing'.

This is being done by (1) presentation of scientific and technical data in the form of papers and discussions, and (2) through the activities of its technical committees appointed to study the properties of the various materials.

The A. S. T. M. prepares the following:—(1) current standards, (2) tentative standards, (3) emergency standards, (4) methods of chemical analysis of metals and non-metals.

The technical committees are responsible for the development of standard specifications and methods of testing. The members constituting the A. S. T. M. include:— (1) producers of raw materials and semi-finished products, (2) consumers of materials, and (3) general interest groups, comprising engineers, scientists, educationalists, testing experts and research workers.

The funds of this society are mostly derived from subscriptions and proceeds of sales of publications. The most important part of its works is that of standardization as applied to both methods of testing and specifications for materials of engineering. A great amount of authoritative data are brought out by the society either as an adjunct to its standardization work or as the result of independent researches. It has about 60 standing committees which include the most outstanding experts of the country in their technical fields. On its executive committee are to be found the heads of some of the Departments of the National Bureau of Standards, sometimes as President, or Vice-President.

The Committees to develop specifications are made up of producers familiar with the limitations of the manufacturing processes, and consumers fully acquainted with the requirements of the various uses to which materials are put.

Before any standardization is done, some research is carried out to obtain the necessary data, and collaborative tests are done by initiating a test programme to supply the necessary information.

Each A. S. T. M. specification, including methods of testing, is issued in the form of a separate pamphlet on the lines of the B. S. Specifications. But the standards, tentative standards, and emergency standards are published collectively once in three years as the Book of A. S. T. M. Standards, consisting of Metals, (Part I), Non-metallic Materials-Constructional, (Part II) and Non-metallic Materials-General. In addition, the Society publishes A. S. T. M., 'Methods of Chemical Analysis of Metals' and also of non-metallic materials.

The Proceedings of the A. S. T. M. include reports of various committees, and technical papers presented before it along with discussions. Special compilations of standards on the basis of these papers pertaining to specific industries are also published separately. In addition to the above the A. S. T. M. issues many useful technical publications from time to time.

Its specifications have attained as much importance as the B. S. Specifications and are also widely adopted even outside the United States.

Enforcement of Standards

It should be added that the institutions above mentioned are not meant to do the policing work. This is done by separate Government departments *e.g.*, the Standard Weights and Measures Department of the Board of Trade in the United Kingdom. Such standards departments act as the custodians of the standards finally accepted by the Government, and their functions include, among other things, 'the periodical comparison of these with their parliamentary copies and verification and re-verification of local standards and scale beams for local authorities and of any standards submitted by other bodies in this country or by any colonies or foreign countries'. The Department examines and supervises over the work of the inspectors appointed to inspect weights, measures, gas meters etc. It also issues regulations relating to the verification and stamping of instruments, such as weights, to the allowable limits and such other things. It secures that these regulations are strictly carried out and that no infringement of the rules occurs. Similar standard departments are maintained at present in almost all the leading countries and are to be found in Berlin, Paris, Rome, Vienna, Leningrad, Madrid, Washington and elsewhere.

CENTRAL GLASS AND SILICATE RESEARCH INSTITUTE

The readers of Science and Culture will recall our editorial and contributed article published some three years ago* when we put forward a strong plea for the establishment of a Central School of Glass Technology. Following the publication of these articles, the Board of Scientific and Industrial Research recommended to the Government of India that a Central Institution for Glass Technology (as envisaged in our editorial) should be established. The Government of India, accepting these recommendations, appointed a Committee to advise the Council of Scientific and Industrial Research in this connection. The report of the Secretary to the Committee (Dr Atma Ram) as accepted by the Committee was considered by the Governing Body of the Council at its recent meeting held at Delhi on 1st August, 1914, and it is hoped that the much needed Central Institute will soon come into being. The Institute is not to confine its activities to glass only ; important branches of ceramics, such as pottery and porcelain, enamels and refractories are also included in the subjects for study at the Institute.

The report is valuable for several reasons: It represents a critical analysis of the present status of the industry and reveals that despite strenuous efforts by the industrialists, it has not made the spectacular advances which glass technology has made during the past 25 years. The position of the industry is viewed against the background of the glass and ceramic industry in the advanced countries of the West, particularly the United Kingdom, the United States of America and Germany, and it is shown that in these countries also the industry during its growth passed through an analogous phase and that Government assistance and technical aid during the past 25 years have led to revolutionary developments which have placed these countries at the vanguard of the world's glass and ceramic producing countries. The report gives a brief account of the varieties of glass and ceramic articles and their numerous applications. The scope for post-war development in India is discussed and it is shown that if the industry is to take its destined place among the major industries, the aid of modern technology which should promote every phase of glass and ceramic manufacture should be enlisted. The most powerful factor in the solution of the numerous impediments to development is *organized scientific research.* One of the important features of the report is the inclusion of several important appendices. The most important of these is the one describing the nature of work done and the part of the technical institutions have played in the development of these industries. The following lines are worthy of note in this connection.

"A review of the progress of glass and silicate industries during the past 25 years, reveals that outstanding developments in the industry are in a large measure due to the labour of physicists and chemists who have solved many problems of great complexity. The engineer has brought about a revolution in the production technique by designing automatic and semi-automatic machinery. A combination of these scientific talents has made at least glass an 'obedient' metal and porcelain a material of far wider utility; the field open for their utilization is now practically unlimited. The notable contribution which these institutions have made to the progress and development of these industries is the establishment of the scientific basis of the manufacturing operations. As a result of systematic studies, they have helped in the production of newer types of articles and in improving the existing technique of production. Above all, they have provided a band of trained workers and have

* Science and Culture, 6, 555-565, 1941.

maintained a consistent supply of trained personnel which is the backbone of modern industries."

The organization of technical institutions concerned with these industries in other countries during the last Great War, has been described in some details. It has been shown that how in the absence of trained men and specialists pure scientists notably Prof. Turner and the late Dr Mellor (both elected Fellows of the Royal Society for their work) developed the Department of Glass Technology at Sheffield and the Mellor Refractories Research Laboratories at Stoke-an-Trent, the leading laboratories in these subjects. We invite the attention of those who always advocate the postponement of the establishment of National Laboratories in India on the plea of war conditions, to those developments that took place during the last war in the country of our rulers. The question of personnel for such institutes is another argument occasionally put forward against their establishment during the war. We reproduce below an extract from our earlier editorial.

"Whenever a proposal is put forward for the organization of such a department, the question regarding the availability of expert technicians is invariably raised. The failure to organize such departments with the help of foreign experts, whether under Government or private bodies, has been amply demonstrated. We feel that India will have to develop such institutions with the help of her own talents. If Turner and Peedle (Dr Peddle was the first research scholar in glass technology under Prof. Turner, and has been largely responsible for the development of optical glass industry in England) in England, Washburn in America, Keppler in Germany, who started their activities in glass and ceramic technology as pure scientists, could develop leading institutions in these subjects, there is every reason to believe that capable Indian scientists and graduates with industrial equipment will succeed in establishing the much needed institution. We should now shake off our inferiority complex and have confidence in the capability of Indian talents. Some people in this country, particularly those in high position are charmed with foreign experts because they think that like magicians of the Arabian Nights Entertainment they should be able to develop an industry overnight with minimum of capital and effort. But the experience of Indian glass manufacturers in this line has not been encouraging."

We should not always look to other countries for supplying us the necessary personnel and should not also expect them to spare their badly needed experts. There is sometimes a tendency to expect spectacular results too early and this may have been the cause of the premature abandonment of many developments. The organization of laboratories takes time and after all the laboratories in other countries were not developed in a day.

Present Position

The history of the Indian glass industry has been discussed in several articles appearing in our columns. A remarkable feature of the industry is that it shows signs of prosperity and progress whenever economic up-heavals, such as those prevalent during the present war in Europe and Japan which have prevented these countries from exporting glassware into India. This is a positive proof that the industry has sufficient potentiality to meet the needs of the home market and constitutes a powerful argument for the grant of tariff protection to enable the industry to grow. What public support could do for the industry is clearly and unequivocally demonstrated by the prosperity which the industry enjoyed during the Swadeshi Movement of 1930. These considerations make it clear that there is nothing inherently defective in the industry—but that the industry has never had enjoyed a lay spell of prosperity to enable itself to overcome the difficulties which have blocked progress. The apathy of the Government has contributed in no small measure to this stagnation. The enquiries of the Indian Industrial Commission and the Indian Tariff Board have served to confirm this view. Both these agencies have pointed in unambigupus terms that the industry needs Government aid and that it satisfies the conditions laid down by the Fiscal Commission for the grant of protection. But Government support which would have infused life into the industry and retrieved it from the morass of stagnation has not been forthcoming. In fact, but for the vitality inherent to the industry, a vitality which in no small measure is due to the natural advantage-availability of raw materials, a prodigous home market, cheap and efficient labour and the tenacity of our manufacturers, the industry would have died out in the post-Great War period. What little has been done for the advancement of the glass industry is mostly through non-official agency, such as the Paisa Fund. A stage has arrived when further progress will be achieved only through the establishment of one or more research stations for the scientific study of the processes of manufacture, for laying down specifications and for testing the raw materials and finished goods. In fact, the Institute is being established with these functions which are stated to be:—

"(1) As an up-to-date Research Laboratory where knowledge of the fundamental sciences of physics, physical and inorganic chemistry, engineering, etc., will be utilised to solve the problems which face the glass and ceramic manufacturers to-day and are expected to confront them when competition from foreign countries will have to be met,

(2) As a testing and standardisation laboratory,

(3) As a clearing house for information and data, and

(4) Advanced training."

Requirements of the Industry

A critical appraisal of the requirements of the industry forms a special feature of the re-

port. It has been pointed out that information about the raw materials of the industry is meagre. What we do know is that we do not know enough. The question of efficiency of furnaces both for batch making and for annealing has received very little attention. Furnace building is mostly in the hands of mistries who by training and outlook are competent to duplicate existing furnaces and reproduce all the conditions which have made the furnaces wasteful of fuel. Inventions which have contributed to furnace efficiency, which makes all the differences between success and failure, have hardly infiltrated into the Indian industry. The annealing schedules which vary with each type of glass, have not been determined or adopted with the extraordinary result that glassware passes through the annealing kilns but without getting properly annealed. The newer types of articles which have extended the range of application of glass and porcelain in art and industry, are not being produced in the country, even under the stress of war. The optical glass for instance, which enjoys a high priority among strategic materials, has not been produced in India which is a major base of military operations in the Pacific War Zone. There are other problems, *e.g.*, testing and standardization, on which due emphasis has been laid in the report which can be solved only through scientific research.

Responsibility of the Industry

It is obvious that the mere inauguration of one or several research institutes will not result in spectacular developments in the industry. The industry should have the will to profit by technological developments and it should have the capacity or ability to absorb and to put into practice new ideas and developments evolved through scientific research. The report reveals that there is a widespread desire among the manufacturers to take advantage of new developments but the capacity to initiate new ideas and new techniques can be assured only if trained technologists are placed in charge of manufacturing operations. By reason of the size of the country and the magnitude of the industry, the establishment of one central research and training centre through the agency of Government will be totally inadequate. There are day to day problems which the industry itself can solve and the manufacturers should get together and organise co-operative Associations, an institution which has produced such remarkable results in the United Kingdom under the active and vigilant supervision of the Department of Scientific and Industrial Research. If these efforts of the Council of Scientific and Industrial Research are supplemented through tariff protection over a stipulated period so that when the industry is deeply concentrating its attention on consolidation and development, it is not subjected to the paralysing efforts of competition from more advanced foreign countries, the industry will obtain a measure of benign assistance, which will ensure its advancement on sound and fruitful lines and give it the necessary strength to occupy its destined place to major Indian industries of the Post-War period.

From the financial standpoint, the scheme is estimated to involve a non-recurring expenditure of about Rs. 12 lacs and a recurring expenditure of Rs. 1½ lacs in the initial stages, increasing to about Rs. 3 lacs. In view of the total production of these industries being about Rs. 5 crores, the recurring expenditure does even come to *one per cent.* We believe these are very modest estimates and in view of the very important part these industries are to play in the future development and in view of their present unsatisfactory conditions, the Government should provide these funds and the industry should also make its generous contribution. Dr Atma Ram has done a great service both to the industry and the public alike by presenting the case of these important industries in a critical and impartial manner and it is our earnest hope that the proposals embodied in the report will soon be implemented.

IMPROVEMENTS OF RICE YIELDS IN INDIA

S. P. AIYAR

India compared to Foreign Countries

THE average yield of paddy in India is estimated to be about 800 lb. per acre[1] whereas the yield in Japan, Italy, and Spain is about 3,000 to 6,000 lb. per acre.[2] One may also quote the phenomenal yield of 10,000 lb. per acre obtained in the valley of the Murrumbridgee River in New South Wales[3,4]. The low yield of India has been the subject of much adverse criticism against the Agricultural Departments in India. This criticism may be countered by a reference to the relatively low yield of rice in Java[2], a country which is a model of perfection in agricultural research. It must also be remembered that in India rice is grown on vast areas of poor land along with good land.

It is a noteworthy fact that the yield of every crop tends to be a maximum towards the coldward limit of its growth. This statement has been verified on a world wide basis by comparison of the yields of wheat, barley, oats, rice, maize, potatoes and several other crops according to latitude.[5] Many reasons may be suggested for this remarkable advantages possessed by countries in temperate latitudes. These are:

(a) Industrialization, enabling the liberal use of fertilizers;
(b) The practical realization of the fruits of advanced scientific research making available superior technical skill and improved varieties of plants;
(c) Comparative freedom from insect pests and diseases;
(d) Rotation of crops, made profitable by a highly developed animal industry;
(e) In many cases, protection of agriculture by the State;
(f) Favourable temperature and light conditions.

The last factor is, however, by far the most significant.[6] That the limitation imposed by latitude is a very real one has been verified in Malaya where repeated attempts by the research officers failed to raise the yield of paddy beyond about 3,000 lb. per acre.[7] This result does not mean that no improvement is possible in India. A great deal remains to be done, however, before the maximum production can be achieved.

General Lines of Attack

The most valuable contribution may probably be expected to come from the plant breeders in India. There are indications of success but the possibilities have not been fully explored. The handsome yield of 5,000 lb. per acre has been recorded at Coimbatore mainly by the use of the improved strain of paddy GEB '24.[8] It appears that the limitation imposed by latitude may partly at least be circumvented by breeding methods. An experienced botanist has pointed out that it would be advantageous if in future the plant breeder devoted more attention to the coarser varieties of rice than to the finer rices which now get most of his attention.

The engineer has important contributions to make by providing an adequate water supply to supplement the rainfall. It has been estimated that the minimum annual rainfall required for successful paddy growing without irrigation is about 50 inches.

The control of insect pests and diseases is likely to influence the yield of paddy to an appreciable extent. Unfortunately the crop will have already suffered before the trouble is noticed and control measures are applied. A great deal remains to be discovered about the factors which predispose the plant to attacks by insects and fungi. There is evidence that the composition of the paddy plant is greatly modified by nutritional deficiencies or excesses.[9] An increase in sugar content or nitrogen content, for instance, may attract insects and fungi. These are fruitful fields of research and may be left to the specialists concerned.

Discussions of Yield Factors

As is well known, yield is a complex expression of the effect of all the relevant factors. Until all the factors are present in proper proportion maximum yield cannot be obtained. The tendency to over-simplification of the manurial requirements of a crop is responsible for many of the difficulties involved in maximum production.

An increased yield due to the addition of any fertilizer is generally attributed to one of its constituents. This assumption may be correct in a majority of cases but in a fertilizer such as ammonium sulphate the secondary constituent, sulphate, will be effective when there is a sulphate deficiency in the soil. Obviously cheaper substitutes such as gypsum or sulphur will be equally effective in a case of sulphur deficiency. The expensive constituent nitrogen would therefore be wasted in this case and when emphasis is placed on the nitrogen only, the practical man expects results by the use of other nitrogen fertilizers and confusion arises when he fails to obtain an increase in this way.

Again, when a fertilizer produces no effect on yield it is commonly assumed that the added element in the fertilizer is not required by the plant and that the soil is well supplied with this element. Very often, however, the added element is not effective due to the unsuitable form in which it is applied, intensive absorption by the soil or assimilation by microorganisms, or again due to the deficiency of some other factor such as water supply, humidity, minor element, and so on. In fact, a negative result in manuring should not induce complacency but should serve as a stimulus to further research.

One of the chief reasons for the unsatisfactory position in India in respect of information on manuring is the fact that most of the work is done on the trial and error basis by propaganda officers with emphasis on the economic aspects only. Most manurial trials appear to have been restricted to nitrogen and phosphoric acid used in the form of compounds with straightforward composition but often camouflaged under fancy names. Rock phosphate, for instance, is generally quite ineffective, and yet numerous trials are made with it merely because it is marketed under different names. It appears

that agricultural chemists in India are merely called upon to analyse samples of soils, fertilizers and the like, and perhaps asked to tender "advice". The ordinary cultivator rarely asks for advice partly due to lack of education and partly due to lack of faith. One may imagine the position if, say, a thousand ordinary cultivators are asked for departmental advice every year in regard to the manuring of their fields.

The author strongly believes that agricultural chemists should devote more attention to actual plant growing experiments and to a study of the composition and abnormalities of the crop. This work should be done purely from the scientific standpoint as distinct from economic consideration. When a chemist reports that a soil contains a low percentage of, say, phosphoric acid, it is his duty to discover whether the plant growing in that soil suffers from any abnormality and whether the application of phosphoric acid corrects the trouble. Further, if the treatment does not succeed it is also his duty to discover the reasons for the failure and to prescribe additional or alternative treatments. Field demonstrations may then be taken up in collaboration with the District Officers.

The various factors likely to modify the yield may now be considered.

(a) Effect of Light and Temperature.—Although experimental control of these two factors may not be practicable in the field it is necessary to take note of them as important factors modifying the yield of paddy. The number of sunshine-hours during the growing season appears to be a varietal constant in paddy. Moreover, paddy is very sensitive to the length of day and, in most cases, flowering is absolutely controlled by the factor. In view of this phenomenon the selection and breeding of varieties must be suited to the light conditions of different localities, particularly the length of day.

High as well as low temperatures may be harmful to paddy. The standing water in a paddy field may easily attain a temperature of 50°—60° during the day, especially in irrigated areas. A low temperature reduces tillering and may prevent flowering but the effects depend on the variety grown.

(b) Effect of Water Supply.—The water requirement of the paddy crop is often reported but it does not appear to have been put to any use. A depth of 4-6 inches of water in the field seems to be sufficient for most varieties of paddy. The standing water maintains the soil in proper condition for the crop and also controls the weeds. An important function of water in the paddy field is to maintain a high humidity in the atmosphere which has been stated to be essential for proper pollination in paddy.[10] The question whether a field can produce one crop or two crops of paddy depends ultimately on the available water supply.

(c) The Soil Factor.—Apparently paddy is very tolerant of physical conditions in the soil. The main requirement is the ability to retain water. Clay soils are therefore preferred for paddy, though there is the possibility that heavy soils are slow to dry out and may thus delay the ripening of the crop. Sandy soils may be used for paddy growing in regions of high rainfall but such soils should at least have an impervious subsoil under irrigated conditions for economic reasons. Occasionally it is suggested that drainage is essential in paddy soils and that crumb structure is important. These claims seem to be unwarranted in view of the fact that paddy fields are deliberately puddled to render the soil waterproof. The slow surface movement of the water has also no advantage apparently.

Soil reaction of a very wide range is tolerated by paddy. Reports from Japan claim that paddy prefers a fairly acid soil.[11] In Sierra Leone paddy thrives at a high acidity.[12] On the other hand, in the Punjab and elsewhere paddy grows well at reactions exceeding *p*H 8·0. In water culture the optimum *p*H depends on the composition of the solution, particularly on the relative proportion of ammonium and nitrate-nitrogen. Liming is sometimes recommended for paddy soils of an acid nature but from the limited information available on this problem in India liming is not likely to be useful to the paddy crop even on fairly acid soils. It may be of interest to note that liming of paddy soils was put under Government control in Japan to prevent indiscriminate liming.[13]

The limit for salt content of the soil which can be tolerated by paddy is not known with certainty. The effect of chlorides has received some attention[14, 15] but the low yields sometimes observed in presence of chlorides may have been due to a deficiency of sulphate. The paddy soils of Sierra Leone contain fair amounts of chlorides whereas workers in Hawaii have reported that chlorides are highly toxic in fairly low concentrations.[16] No injury seems to have resulted in an experiment in which paddy was treated with potassium chloride at 1,024 lb. per acre of soil.[17] Such divergent views may probably be reconciled if the available sulphate content of the soil is also taken into account.

(d) The Elements of Nutrition.—The plant depends on the soil for about eleven elements, some major and some minor in regard to the quantities required. In spite of this varied requirements, it appears that the principal demands of the crop are for nitrogen and phosphorus only.

The main facts in regard to the nitrogen manuring of paddy are that this crop prefers ammoniacal nitrogen to the nitrate form, that no nitrification occurs in the paddy field, and that added nitrate may be lost by leaching or denitrification. Of the nitro-

genous fertilizers ammonium sulphate is the most outstanding in its effect while the other chemical ammoniates, such as ammonium chloride, ammonium nitrate, urea, cyanamide, ammonium bicarbonate and others, are poor substitutes for the paddy crop. Apparently the sulphate radical is responsible for the superiority of ammonium sulphate.[18] This observation is supported by the fact that urea mixed with gypsum has given results as good as those given by ammonium sulphate.[19] The organic ammoniates *e.g.*, oil cake, blood meal, green manure and farm yard manure are fairly satisfactory but definitely inferior to ammonium sulphate. Nitrates like sodium nitrate and calcium nitrate are of little use in the field as they are easily lost by leaching, apart from the fact that they do not supply any sulphate.

The nitrogen content of a normal paddy plant tends to be constant at maturity but the actual percentage of nitrogen seems to be of a varietal character. There are thus high nitrogen and low nitrogen paddies. The yield of paddy decreases with increasing nitrogen content of the plant at maturity in any one variety.

A deficiency of phosphoric acid causes the development of certain abnormal features in the paddy plant. Tillering is controlled partly by nitrogen and partly by phosphoric acid.

Phosphate fertilizers are either water soluble like superphosphate or insoluble like bone meal or rock phosphate. There are also many other forms. Superphosphate is universally applicable whereas bone meal is useful only on acid soils with fair amounts of clay. Rock phosphate is quite worthless as a rule.

Potassium does not form any compounds of biological significance within the plant but functions mainly as a catalyst. Apparently limited amounts may suffice as the mobility of potassium within the plant permits repeated re-utilization of the quantity absorbed. Acute potassium deficiency, which may be induced by excess of calcium or undecomposed organic matter, or repeated treatment with fertilizers containing nitrogen and phosphoric acid only may cause abnormalities in paddy but tillering is not much affected.

It is a remarkable fact that potash manures are generally ineffective throughout the tropics even for potash loving crops, whether the potash is applied alone or in combination with nitrogen and phosphoric acid. The inference that tropical soils are well provided with potash cannot, however, be justified from soil analyses. There must be a general reason for the failure of potash to become effective in crop production within the tropics and further research is necessary before this problem can be solved.

In the study of paddy, sulphur has not received the attention it deserves. Like other plants paddy can utilize only sulphate as a source of sulphur. Under paddy field conditions sulphate is completely reduced to sulphide, or other forms so that deficiency of sulphate must be more widespread than is commonly suspected in the case of the paddy crop. It may be suggested that complete starvation is probably prevented by the existence of secondary reactions. The sulphide may react with ferric iron giving rise to ferrous sulphide which, as is well known, can undergo rapid oxidation to ferrous sulphate from which the paddy plant may obtain both iron and sulphate. The oxygen required for the reaction is probably produced by the action of algae. The vague claim that paddy roots require aeration would thus receive scientific support.

Calcium and magnesium probably play important rôles in the nutrition of paddy but precise information does not exist. Magnesium has been repeatedly mentioned as specially significant for paddy but field evidence is almost non-existent.

Among the minor elements, iron, manganese, boron and copper appear to be essential. Excess of manganese is known to be toxic. Boron and copper are also very toxic except in traces. Root formation is almost completely suppressed by small amounts of copper in water culture. The claim that manuring the crop with copper sulphate gave increased yields must be accepted with reserve. In any case the soil must have protected the crop against injury from copper. Zinc, molybdenum, and cobalt have been found to be useful for certain crops but their significance in regard to paddy remains to be properly investigated.

(*e*) *Varietal Response.*—Manuring practice must take note of the varietal character. Some varieties respond more than others to manuring. There is at present little information on this subject in India.

(*f*) *Agricultural Practices.*—There are many practices associated with paddy cultivation. The practice of transplanting is almost universal. Among others one may mention the rab system, silting, burning the stubble, ratooning, encouragement or suppression of algal growth and so on. However, these are of limited significance and are generally restricted to certain localities. There is no uniformity even in such important preliminaries as ploughing and preparation of the land. It has been claimed that early transplanting, double transplanting, and harrowing the crop have given increased yields of paddy.

Recommendations

The above summary is not complete in every respect but it covers a wide field and indicates the lines for further research. At present, however, the main problem is to adopt practical measures. One may recommend the use of high yielding varieties,

the provision of adequate water supply and the intensive use of fertilizers. The difficulty in adopting these suggestions is the inadequate supply of each of the items required.

Even assuming the simplified formula that much improvement in the yield of paddy is possible by the use of ammonium sulphate and superphosphate alone one is faced with the problem of supply. If every sulphuric acid plant in India were to divert its total production of acid to the manufacture of superphosphate from bones for 2 or 3 months a large stock may be accumulated. Ammonium sulphate is a more difficult problem as the existing Indian resources are quite small. Substitutes, such as oil cakes, may be useful but, in the author's view, cannot adequately replace ammonium sulphate.

The quantity of fertilizer to be applied must be adequate for the purpose in view. The minimum rate of application should be between 40 and 80 lb. of nitrogen and phosphoric acid per acre, preferably in the form of ammonium sulphate and superphosphate respectively. It will be useless to apply smaller doses over a wider area if increase in yield is the paramount consideration. It must also be mentioned that manauring the seedbed is of doubtful value for increasing the yield of crop.

While such temporary war time measures are in progress fundamental researches should be initiated to discover the full facts about paddy nutrition and fill up the numerous gaps in our knowledge of this subject. The time is opportune, as war conditions have brought into prominence the insufficient food supply in the country and the weak position of the rice eating areas. It is hoped, therefore, that fundamental researches would receive encouragement and adequate financial support.

Concluding Remarks

In conclusion, attention may be drawn to the need for improving the methods of carrying out agricultural experiments. At present experiments are laid down on farms and sometimes on cultivators' fields without regard to the soil. A great deal of trouble is taken to satisfy the statistician on the layout, and the significance of any differences produced by treatments is also worked out with care. These are, of course, necessary details in every experiment. The results obtained are, however, of limited application and may not hold good on soils outside the plots actually tested. Field experiments could be made more rational and capable of better generalization by paying attention to the soil. There is now apparently a deep rooted but erroneous idea that one soil is much like another. As typical of this attitude one finds in a recent bulletin on the manuring of paddy published by the I. C. A. R. that the results of an experiment carried out at Pattambi Farm are assumed to hold good for the whole of Malabar. It will be manifestly absurd to assume that Nagina represents the whole of the U. P., or that Sabour represents the whole of Bihar. To overcome such handicaps a soil map is absolutely essential. This map must be based on the results of a genuine soil survey undertaken to demarcate the boundaries between pedological soil types identified on an objective basis. Unfortunately such a map does not exist at present owing to lack of data and it may be many years before this map takes shape. A limited number of experiments conducted on each soil type can serve to generalize the information for that soil type. The position of a field may be easily identified on the soil map and it is then a simple matter to advise the cultivator on the manuring of his field.

There is another aspect of the soil which must receive attention. Every soil on which field experiments are being planned should be tested to discover the full manurial requirements. This step is carried out partly by analysis of the soil and partly by pot experiments which should include not only the usual N, P, K in all combinations but also other significant elements, such as sulphur, manganese and so on. The treatment rate should be fairly high for major elements, *e.g.*, 80 lb. P_2O_5 per acre. The crop should be analyzed to secure additional information. It must be emphasized that a pot experiment is economical and can give reliable qualitative information on the elements that may have to be added as fertilizers. Again, new fertilizers and fancy fertilizers are best tested in pots for the sake of economy. Pot experiments have been very successfully employed by the author in tracing the causes of certain physiological disorders of paddy.

Much of the antagonism to pot experiments is derived from unsuccessful but unjustifiable attempts in the past to apply these qualitative results to the field without any modification. In fact field experiments are essential to demonstrate and supplement the practical value of the information obtained by laboratory and pot experiments. Having established the manurial requirements for any given soil type, field experiments should be carried out at different centres on that soil type to determine the dosages required to produce maximum yields. The same procedure will have to be followed for every other soil type.

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THE HERBARIUM*

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INTRODUCTION

THE 'Herbarium' means a collection of dried plants or a book containing such pressed plants and also a place where such a collection of plant materials are kept. The word 'Herbarium' used in the modern sense makes its first appearance in print in Pitton de Tournefort's Elements of 1694.

The herbalists are considered as the first to recognize the use of dried plants in dealing with herbs for medicinal purposes. This is the utilitarian standpoint of studying plants. The other standpoint from which the plants were studied in ancient times was philosophical as revealed in the writings of Aristotle and Theophrastus. In India records of such a study can be traced from the scriptures and treatises on medical science written by the sages of great antiquity about 2500 years ago.

In Europe the work of the herbalists can be traced to 1470 and evolution of the herbals ended in about 1670 when came the period of renaissance in botanical studies in Europe. The botanical science from this time gradually developed on modern lines and made rapid progress during the last two centuries.

The collections of dried plants hold unique position towards advancing our knowledge of plants, although we owe a deep debt of gratitude to certain branches of arts especially printing and wood engraving of the fifteenth and sixteenth centuries or even earlier. The draughtsman and engraver, indeed, did more than merely dessiminate existing knowledge. They lent the botanist their acute and highly trained powers of observations and their work must often have revealed to him much of what he would never have seen without their help. Before the existence of herbarium and the discovery of the art of printing, the herbal tradition in the study of plants passed through a period of 2,000 years from the Hindoo sages and savants to Krateus, the Greek to an old woman "poring over her well-thumbed picture book in an English village."

ORIGIN OF HERBARIUM

The origin of the herbarium can be traced to the Italian botanist Luca Ghini who in 1490 and onwards was the sole initiator in the renaissance period of the art of herbarium making. His method of preparation of pressed plants was then dessiminated over Europe by his pupils. Luca Ghini was professor of Bologna University and worked at Pisa for sometime. He sent dried plants gummed upon paper to Mattioli in 1551. He possessed about three hundred pressed specimens at that period. This collection which must have existed long before 1551 was lost to science, but Luca Ghini's pupil Gherardo Cibo began to collect at least as early as 1532. Among the earlier collectors who possessed herbarium are John Folconer (1553) who travelled in Italy and evidently learned the method of preparing herbarium specimens from Ghini and Turner, Aldrovandi and Casalpino, the three Ghini's pupils, who made good herbarium at this period. Aldrovandi was the first to aim at a collection of dried plants of the whole world. The herbarium of Felix Platter is of great value. Ranwolf established a herbarium in Leyden in 1576. The value of the herbarium specimens as a source of pictures of plants of distant parts of the world was soon realized from this time when the word herbarium meant generally a book of plants or *Flora exsicata*.

In such an early time Mattioli mentions even the practice of soaking dried plant materials for examination and sketching in order to restore their natural appearance. "Information about the making of herbaria must have transmitted by word of mouth alone for more than seventy years, for it was apparently not until the publication in 1606 of Adrian Spieghel's 'Isagoges', that detailed instructions for forming a collection of dried plants became available in print. Spieghel, a native of Brussels, finally occupied the chair at Padua. In his 'Isagoges'—a general treatise on botany—he explains the method of pressing between sheets of good paper under gradually increasing weights and notes that the plants must be examined and turned over daily. "When they are dry they are to be laid upon inferior paper ("charta ignobilior") and, with brushes of graded sizes,

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painted with a special gum, for which he gives the recipe. The plants are then to be transferred to sheets of white paper ; linen is to be laid over them and rubbed steadily until they adhere to the paper. Finally the sheets are to be placed between paper, or in a book, and subjected to pressure until the gum dries."

It is interesting to note that the technique of herbarium making adopted three hundred years ago is more or less followed even in the present time. The science and art of preparing herbarium specimens however has reached a very high standard in these days and various methods and recipe for treating different kinds of plants have been suggested by various workers in different herbaria. The methods of collection and preservation of plants has been dealt with exhaustively by G. N. Johnson with a foreward by Prof. E. D. Merill, of the Harvard University and Director and Administrator of the New York Botanic Garden and Herbarium in the Arnold Arboratum. This treatise entitled the preparation of botanical specimens for the herbarium was published by the Arnold Arboretum of Harvard University in 1939. It would be too long to discuss the subject here but one point I must impress upon the botanists and amateur collectors that in all cases complete materials should be gathered for identification and study of a plant. By complete material I mean the whole plant with flowers and fruits, where possible, or at least a portion of the plant with flowers, fruits and vegetative parts all in tact. Sterile material is useless for herbarium purposes and proves difficult if not almost impossible, for the purpose of definite determination.

In a modern herbarium is deposited in classified order complete collection of dried plants of a country or different countries of the world. On the sheet of herbarium specimens are noted the specific name of the plant, the name of the locality with elevation from which it has been collected, the habitat of the plant, the name of the collector and the date of collection, the period of flowering and fruiting and other remarks regarding the ecological conditions and economic value of the plant and so on. The value of the herbarium lies in possessing type and co-type sheets, that is, the original specimens of the discoverer of the plant and authentic duplicates of the same. In India such sheets are available only at the herbarium of the Royal Botanic Garden, Calcutta.

The Work of the Curator of the Herbarium

The officer-in-charge of a recognized herbarium, such as the herbarium of the Royal Botanic Garden, Calcutta, is called the Curator or the Keeper of the herbarium. The curator must be a botanist with special knowledge in systematic botany and taxonomy and should have sufficient training in large herbaria and experience of the work done in the leading herbaria of the world with whom he has to communicate regularly in connection with the scientific aspect of his work. The curator's daily work is to keep constant watch and attention to the preservation and maintenance of the herbarium specimens. This task is really exacting when the herbarium is situated in the tropical atmosphere. Each sheet of specimen requires very careful handling so that a specimen preserved for hundreds of years may not be damaged and thus lost to science. The specimens in a damp climate require also frequent treatment with prescribed chemicals in solution or in powder form to keep off the attack of insects and moulds. The herbarium building must be properly ventilated and should not be too hot and too moist although a little moisture is required for keeping the specimens properly stretched and glued on the mounting paper. Too dry atmospheric condition makes the specimens brittle and susceptable to drop off the sheets. The main scientific work of the herbarium is identification, loan and exchange of materials, supply of various information on the occurrence, distribution, nomenclature and uses of the plant sent for examination and, last but not least, the research work in systematic botany. The work of identification is by no means less arduous than the other items of work. As soon as a plant is received it is recorded in the register and handed over to the expert comparer after ascertaining the family to which it belongs. The herbarium assistants then match the specimen with the one which comes closest to it. The curator then has to examine the descriptions, illustrations of the plant matched and then declare the name of the plant. The name again requires often to be modified in the light of the International Rules of botanical nomenclature. Specimens are exchanged with the various herbaria. Photographs of types and co-type sheets are sent with critical notes and observations on the systematic position of the species of plant to different workers in the various parts of the world. Acquisition of specimens by exploration of unknown and little known areas, writing of floras based on collected materials, ecological study of the vegetation of a country or part of a country, survey and analysis of the flora with a view to silvicultural, arboricultural, horticultural, agricultural and plantation purposes, preparation of regional vegetation maps and so on are some of the important items of work which devolves on the scientific officers-in-charge of a herbarium. On their work depends the advancement of botanical studies in the universities and researches on pure and applied aspects of botany. The latter aspect of investigation is of great importance in commercial and industrial development of a country.

In the different cities of Europe more than twenty herbaria are preserved which were formed or at least begun in the sixteenth century. In India the oldest herbarium was formed by William Roxburgh in the end of the 18th century soon after the foundation of the famous Royal Botanic Garden, Calcutta, in the year 1787 by Col. Robert Kyd. The other important herbaria are the Madras Herbarium at Coimbatore (1874), the Herbarium of Economic Botanists at Poona, Bombay Presidency (1880), the Forest Herbarium of the Imperial Forest Research Institute at Dehra Dun (1890) and the Shillong Herbarium of the Forest Department of Assam which was started systematically by the late Rai Bahadur U. N. Kanjilal of the Forest Service. All these are however daughter herbaria which were fostered in the early days by the Herbarium at Calcutta in various ways and still receive collaboration in their floristic and other work relating to scientific problems. Many leading herbaria in Europe and America also receive help and co-operation in the nature of exchange of specimens, loan of specimens, presentation of specimens and preparation of floras and in connection with their various floristic and taxonomical investigations. There are herbaria attached to the different universities in India and other countries of the world; but most of these are meant for teaching purposes.

In the scientific arrangement of the specimens different systems of classification are followed in the different herbaria of the world. The Government herbaria in the British Empire generally follow the classification of Bentham and Hooker, as laid down in their Genera Plantarum (1862-93), but in the Continent many modern herbaria generally adopt the system of classification as outlined by A. Engler and E. Gilg in their syllabus der Pflanzen Familien (1924). Most of the universities also follow this highly evolved natural system as it is considered the best with regard to its masterly treatment of the families, genera and species and their affinities under different classes of plant kingdom from the simplest to the most highly advanced forms of plant life.

An ideal herbarium must have an equally good library along with it, and it is essential that it should be associated with a botanical garden for the cultivation of as many species as possible in order to study the range of variations in a plant under living conditions. The Herbarium of the Royal Botanic Garden, Calcutta, and the Herbarium of the Royal Botanic Garden, Kew, fulfil really all the conditions of a perfect herbarium, and they are the source of botanical information in the East and the West. The Herbarium of the Royal Botanic Garden, Calcutta, bears a close similarity to the Kew Garden, the largest botanical garden, but younger than the Calcutta Garden by fifty years. There are in the Royal Botanic Garden, Calcutta about 15,000 plants actually under cultivation in the open in its respective regional divisions. In addition to this living tropical collection of plants, the Lloyd Botanic Garden, Darjeeling, represents more than thousand temperate plants and possesses more or less a complete local herbarium.

The library contains more than 25,000 volumes, numerous pamphlets and the most valuable set of about 2,500 magnificent large portfolio size coloured illustrations of the Indian plants bound in 35 volumes. These plants are described by Roxburgh in his flora entitled "Flora Indica" on which all subsequent Indian floras are more or less based. This Roxburgh's Icones, as it is called, is perhaps the only complete set of its kind in the world. Other equally valuable paintings of Indian plants and documents of famous botanists are carefully preserved in the Sibpur Herbarium building, the sanctuary of botanical science in India.

The present damp-proof and fire-proof building especially designed to house nearly two and a half million authentic sheets of herbarium specimens which form the basis of all botanical and allied investigations was erected in 1883. In this herbarium all these precious sheets consisting of irreplaceable types, co-types, lecto-types, eco-types, etc., are arranged in proper scientific order. The herbarium is thus the depository of a very complete collection of the dried materials of plants of the whole of Indian Empire as also fair collections of those of Asia outside India, of Europe and Australia. Plants of Africa and America are partly represented. For the systematic botanists, forest officers, herbalists, druggists, pharmacologists, industrialists and others interested in plants, this herbarium is the most interesting and valuable spot in Asia. This is the only place for botanical investigation of its kind in India and is recognized as the best herbarium not only in India but also in the East by the international botanical organization of the world. This herbarium is, as the late Sir Arthur Hill, Director, Royal Botanic Garden, Kew, remarked, "the Mecca for the study of Systematic Botany by botanists not only in India but from overseas." It will be interesting to note here what Sir Richard Temple, a Lieutenant Governor of Bengal said on the utility of a herbarium as early as 1870.

"The collection is and will always be most useful in dealing with questions regarding the naturalization of plants, the introduction of new vegetable products into the country, the adaptation of raw produce to the growing requirements, of manufacturing industry, the management of the forests and the scientific improvement of Agriculture."

Introduction of quinine, rubber, ipecacuanha, various timber trees, fibre and oil yielding plants and other plants of great economic value is mainly due

to exploration by the scientific officers of the Herbarium of the Royal Botanic Garden, Calcutta.

The Herbarium and the Royal Botanic Garden have thus served the mankind for an unbroken period of more than a century and a half. It is therefore quite natural that the Indian botanists declared in 1938 at the Silver Jubilee session of Indian Science Congress held in Calcutta that the Herbarium of the Royal Botanic Garden, Calcutta, should be the National Herbarium of India.

THE LATE PROF. K. S. K. IYENGAR

THE sudden and unexpected death from pneumonia of Prof. K. S. K. Iyengar on 23rd June, 1944 at Mysore came as a shock to all those who knew him and his work. The event is all the more tragic as Professor Iyengar was only 45 and at the height of his powers. My purpose in this note is only to pay a *personal tribute* to one of India's most distinguished mathematicians. For further details about Iyengar's life and his research work in pure mathematics, which was after all the main subject of his life, I refer the reader to an obituary in the *Proceedings of the Indian Academy of Sciences* (June, 1944), of which Iyengar was a Fellow.

Kombur Sesha Iyengar Kuppuswamy Iyengar war born on the 29th August, 1899. The foundations of his mathematical education were laid at Central College, Bangalore and later at Presidency College, Madras, where he passed the Honours Examination of the M.Sc. degree with distinction in 1920. Having shown unusual mathematical ability he was sent by his parents to study mathematics at Cambridge, where he passed the Mathematics Tripos as a star wrangler

Prof. K. S. K. Iyengar.

in 1924. In Cambridge he met Prof. Littlewood and came under the influence of the great mathematical tradition of that University. Prof. Littlewood and the other mathematicians with whom he worked at Cambridge thought very highly of him, and he appears to have won their respect by his "genuine enthusiasm for mathematics" and "high ability."

I first met Iyengar in 1940 when I came to the Indian Institute of Science, Bangalore. He was the head of the Department of Mathematics of the University of Mysore which is housed at the Central College, Bangalore. He was appointed to this post in 1926 on his return to India from Cambridge. That this department today is one of the best centres of mathematical teaching in India is due in no small measure to Iyengar's active enthusiasm and wide knowledge of different branches of mathematics, and to the excellent group of able young mathematicians that he collected around him. He followed closely the latest developments in mathematics and I remember well the enthusiasm with which he spoke about the remarkable school of modern Russian Mathematicians and the new methods they had developed.

It was early in 1941 that I took up again with S. K. Chakrabarty the problem of giving a better treatment of the cascade theory of cosmic ray showers than had been done hitherto. Members of the staff of the Central College, including Prof. Iyengar participated in our colloquia and it was at this time that I put forward to him the problem of finding an exact solution of the fundamental equations of the cascade theory. The problem involves the solution of a rather complicated integro-differential equation. Hitherto only partial solutions of this problem, fairly accurate for high energies, had been given. In all these solutions the collision loss suffered by the cascade electrons, which is vital for the absorption of the shower, had either been neglected altogether, or treated by such defective mathematical approximations as to be worth little. This neglect completely prevented a calculation of the low energy spectrum of cascade electrons. In the processes of radiation loss and pair creation incompleteness of screening was neglected and the asymptotic expansions for extremely high energies used. This approximation is not serious and must be avoided only for relatively low energies especially in heavy substances. It was during this

period that I evolved with Chakrabarty a solution in the form of an infinite series which took account of the collision loss exactly, but still neglected incompleteness of screening. In subsequent work Chakrabarty has given method for taking incompleteness of screening into account approximately. On the other hand, by an extremely ingenious use of the solution of the cascade theory for extremely high energies and neglecting collision loss, which had been given by Landau and Rumer, Iyengar was able to give a remarkable and complete solution of the cascade problem. His solution not only takes account of the collision loss of electrons, but also of incompleteness of screening with mathematical rigour. In my opinion this solution shows Iyengar's profound grasp of mathematical methods and his remarkable ability, especially when one considers that this was an outstanding problem which has been tried by mathematical physicists all over the world. Iyengar was not a physicist and was not interested in obtaining the numerical results required by experimental physicists. Indeed, for this purpose it is simpler to turn to the series solution given by Chakrabarty and myself the first term of which is a powerful approximation from which numerical results can be calculated with a reasonable amount of labour in all except a few special cases. Iyengar's solution however remains the only one which takes account of the incompleteness of screening exactly, and is valid for all energies and all thicknesses. One day when an increase in the accuracy of experimental data requires a more accurate knowledge of the results of theory than can be obtained by other methods, perhaps Iyengar's solution will be used to obtain these exact results with the help of a calculating machine.

K. S. K. Iyengar's premature death is not only a loss to those who knew him but has deprived India of one of her ablest and most promising mathematicians.

H. J. Bhabha.

OBITUARY: DR E. L. G. CLEGG

By the death of Dr E. L. G. Clegg, Director of the Geological Survey of India in Calcutta at the early age of 50 the Government of India have lost an outstanding administrator and scientist at a critical time when they can ill afford it.

Dr Clegg was born at Manchester in 1894. He was educated in the Central High School and in the Victoria University, Manchester. He served through the 1914-18 war as an officer in the Northumberland Fusiliers and saw much active service in France and Italy.

After the war he took his M.Sc. (Geology) in Manchester and came to India as an Assistant Superintendent, Geological Survey of India on the 1st December, 1920. He was attached to the Central Provinces and Bihar Circle under Sir L. L. Fermor and carried out some valuable mapping in the Chindwara District of the Central Provinces.

The following year he was sent to Burma where he spent 4 years mapping the geology of parts of Minbu and Thayetmyo Districts. The important work then done by him was subsequently published as a *Memoir* of the Geological Survey of India. In 1938 Manchester University conferred on him the degree of Doctor of Science in recognition of this valuable piece of work.

In 1926 he returned to India and remained in Calcutta first as Curator and then as Officer-in-Charge of the Geological Survey Office. During this period he acted as Lecturer in Geology at Presidency College, Calcutta and in the Bengal Engineering College, Sibpur. In addition he took a keen interest in the work of the Mining & Geological Institute of India and acted as one of the Joint Honorary Secretaries

Dr. E. L. G. Clegg.

from 1927 to 1930, and was Vice-President in 1943. Returning from long leave in 1931 he remained in charge of the Calcutta office for another year and was then transferred again to Rangoon in charge of the Burma Party.

During the next three years of his service he made a detailed map of the Mogok area in Burma,

and numerous traverses in the defiles of the Irrawaddy, the Jade Mines District, Lai Sai State, and along the Uyu river.

The results of this work were published in 1941 under the title "The Cretaceous and Associated Rocks of Burma". In this Clegg reaches the interesting conclusion that the gem-bearing limestones of Mogok are metamorphosed cretaceous limestones.

As Officer-in-Charge of the Burma Party Clegg had excellent opportunities of visiting the Burmese mineral deposits. He also got an intimate knowledge of the Burma oil fields when acting as Resident Geologist at Yenangyaung in 1935 and 1936. In spite of the heavy administrative work connected with these two posts he was able to make full use of the information he had accumulated at this time in a valuable account of the "Mineral Deposits of Burma" and later, in 1944, in a *bulletin* on "Tin and Wolfram".

Clegg returned to India from Foreign Service in Burma on the 26th June, 1942. On the way he did a valuable traverse through the Hukawng Valley for the military. On his arrival in India he was put in charge of the Central Provinces Party and later for a short time of the Sulphur Operations at Koh-i-Sultan in Baluchistan.

When Sir Cyril Fox retired in July 1943, Clegg became Director of the Geological Survey of India and carried out the functions of that important post with conspicuous success till his death.

As a young man Clegg played Rugby for Manchester University and captained their waterpolo side. While in Calcutta he played for the Services Rugby team and was one of their best forwards. He also won the Calcutta Place Kicking Cup on one or more occasions. Perhaps as a result of his early training in athletics he was always tireless in his field work.

Clegg shone at administration perhaps more than in his scientific work, but his writings prove that he had a clear practical brain, excellent judgment and considerable imagination. These qualities proved particularly valuable to him in advising on the many problems of engineering geology which he was expected to solve. He will be a very great loss to Indian Science and Engineering.

As a man he combined the 'pitho's sense and pride 'o worth' with a very pretty wit. The Geological Survey of India and his many friends both in India and Burma will long miss his cheery face and friendly smile.

H. Crookshank.

Notes and News

DEVELOPMENT OF BENGAL'S POWER RESOURCES

The need for a thorough survey of Bengal's available power resources, thermal and hydro-electric, has been strongly urged by the Electricity Sub-committee of the Bengal Post-War Reconstruction Committee in its exhaustive report just submitted to the Government of India. The Committee has strongly recommended the creation of an expert committee to undertake this survey work and has stressed on the immediate necessity of approaching the Government of India for making available for this province complete initial equipment for early installation of at least one thermal power station of 10,000 k.w. capacity in the coal-field area of Raniganj.

The Committee has expressed its strong confidence in the availability in this province of power resources, both thermal and hydro-electric, needed for her electrification. In view of the present tendency of existing industries towards the substitution of electricity for other forms of power, the Committee feels that the provision of cheap electric power, which through electrification of this province can alone make possible, would act as a definite stimulus to the development of industries. In this connection the Committee cited the example of U.S.S.R. which has achieved phenomenal progress in every sphere of economic activity, industrial, agricultural, and transport, through the development of electrical power.

Regarding the distribution of power through the institution of a grid system, the Committee has expressed its view that the question of the grid formation does not arise at the present stage of electrical development in Bengal but will have to be considered in right earnest as soon as a few large-sized regional stations have come into operation. The Committee endorses the policy of ultimate nationalization of electricity undertakings as already accepted by the Government of Bengal, but stresses that such a policy in regard to State-ownership and

State-management should be scrutinized and clarified as soon as possible.

The Committee has further strongly recommended the creation of an Electricity Supply Board to undertake, among other things, a continued and systematic survey of the power resources of the province and the formation of a permanent body of Commissioners after the example of the Electricity Commission of Great Britain.

THE PAPANASAM ELECTRIC PROJECT

The Papanasam Hydro-thermal Electric Project at the Thambraparani Dam was inaugurated by His Excellency Sir Arthur Hope, Governor of Madras, on August 21, 1944, according to *Hindu*. It now forms the third major hydro-electric project under the Madras Grid system. Designed as a hydro-thermal development, the scheme will at present provide hydro-electric power on a scale commensurate with the economics of the site and has under contemplation the building up of a steam station at some future date, probably at Madura, as demand for greater load develops. It is stated that the present works have cost Rs. 163 lakhs out of the estimated total cost of Rs. 179 lakhs.

The development of the Papanasam hydro-electric power has been made possible by regulating and harnessing the waters of the river Thambraparani which drops about 300 feet over the picturesque Papanasam Falls, through the construction of the Thambraparani Dam and Reservoir about six miles above the falls. Initially expected to yield about 5,700 k.w., the Project has already provided or will very shortly provide a load of 11,000 k.w. It is, however, expected to produce 20,600 k.w. in the tenth year. Although the scheme is primarily intended to supply power to Tinnevelly, Ramnad and Madura districts and the Travancore State, its association with the Madras Grid which links up Mettur, Pykara and Pallivasal in Travancore will enable the new hydro-electric station to promote economic distribution of electric power throughout the province as a whole.

Apart from the generation of useful electrical power, the dam and the reservoir will act as a flood moderator and thus reduce the disastrous damage that occurs periodically in the ayacut, and will further create extensive irrigation facilities by regulating the flow of water. The rainfall in Tinnevelly-Travancore plateau usually varies from 60 to 200 inches a year, and before the construction of the dam this water was simply allowed to run to waste. The construction of the reservoir will now enable the storage of about 5,500 million cubic feet of this water, of which, as the experts estimate, about 1,000 million cubic feet will be available for irrigation purposes. The great benefit which the agricultural population of this region will derive from this development need hardly be over-emphasized.

The Papanasam scheme, as Col. M. G. Platts, Chief Engineer of Electricity, revealed in course of his welcome address, was first investigated in 1920. The execution of the scheme was not, however, undertaken till 1938, because the Governments of earlier decades generally regarded such projects as 'risky ventures', as Col. Platts put it. It is only recently that the Government has come to recognize, and even then reluctantly, the necessity and desirability of power production on a wide scale as an indispensable condition for industrial development and the consequent economic progress. The success of the project in question, as the *Hindu* rightly observes, is largely due to the initiative of the then Congress Ministry which ordered, under pressure of the agriculturists of Tinnevelly, the starting of the preliminary operations necessary for the construction of the dam and the power. The Government of Madras, however, deserves to be congratulated for having decided to continue and complete the scheme during the war despite war-time difficulties regarding transport and the supply of plants and equipments from abroad.

MILK SHORTAGE IN INDIA

Milk shortage in India has assumed alarming proportions during recent years. Attention of the public on this all-important question has already been focussed by the daily Press. Meanwhile, the *Indian Farming* (January, 1944) in its leading article, has published some important statistical information regarding the exact nature of this shortage, which will help formulate the real extent of the need for more milk in this country.

India, with her production of 800,000,000 maunds of milk per year, is the second largest producer of milk in the world after the United States. But her *per capita* consumption of milk or its equivalent in milk products is only 7 oz. per day compared to 35 oz. in the U.S.A. The nutritionists have estimated the daily minimum requirement of milk for a growing child at about 32 oz. and at about 16 oz. for an average adult. It is a clear evidence that an average Indian fails to fulfil his minimum requirement under the existing supply of milk, which should be increased to at least three times the present production if any real improvement in the milk-shortage is to be desired.

The shortage of milk has been rightly ascribed to low capacity of Indian cows for milk production and not to any real shortage of cattle population in this country. The Indian cow on an average produces about 625 lb. of milk annually excluding, however, what the calf gets, whereas the average production of milk in Canada, England, the United

States and other countries varies from 3,500 to 4000 lb. per year. In Denmark, the cows are reported to have produced on an average over 8,000 lb. of milk a year before the war.

Therefore, to meet our minimum need for three times of the quantity of milk now produced all over India, *i.e.*, for 2,400,000,000 maunds per year, the Indian cow should be called upon to produce 1,875 lb. per year, which is still a small figure compared to 4,000 for other countries. This obviously implies increased production of cattle feed. An animal with an average body-weight of 600 lb. requires about 8 lb. of dry matter in the feed daily for proper maintenance only. This figure, however, does not take into account the needs for milking and pregnant cows for which more dry matter is needed. The Indian cow at present does not get more than 4·6 lb. of dry matter from all available fodder, grass and farm waste material which the cattle can make use of. The problem is clearly one of increased production of cattle feed and increased efficiency in the conversion of feed into milk on the part of our cattle. These figures make us wonder how Indian cows at all produce any milk. We cannot expect any reasonable supply of milk from our starving cattle, and this is the crux of the present milk shortage in India.

THE UNITED STATES NATIONAL MUSEUM

The annual report of the United States National Museum, submitted by Dr Alexander Wetmore, Director of the U. S. National Museum, records the present condition of the Museum and the work accomplished in its various departments during the fiscal year ended June 30, 1943. The total appropriation of $892,630, received during the year for the maintenance and operation of the Museum, indicates an increase of $61,652 over the previous year's appropriation. The Museum received, during the year under review, some 1,355,269 visitors from all parts of the United States, a figure which, although slightly less than the peace-time figure, is sufficiently indicative of the continued interest of the U. S. people in the exhibits of the Museum. In comparison with the last year's collections, however, there was a diminution in the number of accessions and specimens received owing largely to the curtailment in field work. But still the Museum collections were on the whole satisfactory, as new material came in 1,177 separate accessions, with a total of 230,231 specimens. They were distributed among the five departments as follows: anthropology, 2,514; biology, 213,823; geology, 9,725; engineering and industries, 2,266; and history, 1,903.

During the year under review, members of the staff were primarily engaged in work calculated to promote the conduct of the war. Data were requested for enumeration work on a variety of subjects which included the following: camouflage plants; natural vegetation of specific regions; illustrations of poisonous plants and of emergency food plants and data regarding them; destruction and mosquito-harbouring epiphytes; distribution of certain plants of known economic importance; botanical exploration; the palatability of the flesh of land, fresh water and marine animals, their use for food and methods of capture; the serviceability of hides and skins for various purposes; disease transmission; noxious, poisonous or otherwise dangerous animals; intermediate hosts of animal and human parasites; aid in the preparation of survival manuals and other military and naval handbooks; distributional lists of insects and other animals of medical importance; outlines for insect surveys in foreign areas; instruction in mosquito identification; collection and preservation of specimens, especially those of medical importance; supplying duplicate sets of insect material not otherwise readily obtainable for the use of Army and Navy medical schools; biological and oceanographic problems; and marine fouling organisms.

INDIAN CENTRAL COTTON COMMITTEE

At the meeting of the Indian Central Cotton Committee, held on the 28th and 29th July, several important decisions were taken of considerable interest to the cotton growers. On the subjects of the floor and ceiling prices of cotton, the necessity of eradicating the malpractice of mixing different varieties of cotton and the urgency of growing more food crops in the present emergency, the following resolutions were unanimously passed:—

(1) The Indian Central Cotton Committee, while taking full cognizance of the gravity of the food situation in the country and of the urgent necessity of increasing the supply of food grains, is unanimously of the opinion that the lowering of floor and ceiling prices for cotton will not achieve the object in view but will only result in severe hardship to the cotton cultivators and seriously interfere with the economic condition of the rural population as a whole.

The Committee considers that the solution of the food shortage problem lies along the avenue of planned production and not in reducing the income of growers of non-food crops to a bare subsistence. To aim at price levels for cotton which will leave the growers only a bare subsistence is a retrograde step which will greatly add to the difficulties of post-war nation building.

It is the considered view of the Committee that the shortage of foodstuffs can best be met by the enforcement of legislation restricting the area under cotton in accordance with a co-ordinated policy of planned production on an all-India basis, without unnecessarily reducing the purchasing power and the already low standard of living of cotton growers.

The Committee is of the opinion that the floor and ceiling prices for the 1944-45 season, announced by Government in their press note dated the 15th July, 1944, are very low. It, therefore, strongly recommends that the fixed floor prices for Jarila and all other styles should be raised by at least Rs. 50/-. In making this recommendation, the Committee has given due regard to the present increased

cost of producing cotton, arising more especially out of the heavy increased cost of consumers' goods, labour, agricultural implements, plough, cattle, etc.

(2) The Indian Central Cotton Committee is convinced that the malpractice of mixing different varieties of cotton is seriously hampering the work of cotton improvement in the country. It is the considered view of the Committee that until this malpractice is made a penal offence, it will be impossible to provide seed of improved varieties of cotton in quantities adequate to meet requirements. In the interests of Indian cotton as a whole, therefore, the Committee is unanimously of the opinion that, as a first step, the mixing of short staple with medium and long staple cotton and of medium with long staple cotton at the factories should be forthwith prohibited by the Government of India by legislation. The Committee further recommends that steps be taken by the Government of India to ensure that the legislation is put into effect by the Provincial and State Governments as soon as possible and, in any case, well in advance of the cotton season commencing 1st September, 1945. The Committee has no doubt that the adoption of the measure suggested by it will have a beneficial effect on the food position of the country for, if the utilization of short staple cotton for mixing purposes is stopped, the production of such cotton would be automatically reduced to the minimum commensurate with requirements.

(3) In view of the paramount importance and urgency of growing more food during the present emergency and in the interests of improvement of Indian cotton in future so as to make its production remunerative to the grower, the Committee is strongly of the opinion that concerted efforts should be made to develop the agricultural resources of the country to the fullest extent possible. The Committee is convinced that the object in view can be achieved by improved methods of farming, suitable rotation of crops, and, above all, where conditions are favourable, by the introduction of mechanical devices for cultural and harvesting operations. It accordingly requests the Government of India to give immediate facilities for manufacture in the country and import from abroad (to meet immediate requirements) of improved implements and machinery and fertilizers.

THE CYCLOTRON OF THE CARNEGIE INSTITUTION

The construction of the new giant cyclotron at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has just been completed, according to *Science*, June 2, 1944. The new cyclotron is reported to be the second largest in the world after the one at Berkeley under the supervision of Professor E. O. Lawrence and generates atom-smashing projectiles of 15 million electron volts energy. The cyclotron weighs more than 225 tons, has an overall height of 12 feet, is 30 feet long and 20 feet wide. The magnet is made up of four iron castings, of which the largest weighs more than 30 tons. This heavy magnet surrounds the accelerating chamber, *i.e.*, the Dees, having a diameter of about 60 inches. The cyclotron has a supply of 100 k.w. radio frequency and operates at 10 megacycles.

The cyclotron of the Carnegie Institution has been housed 10 feet below the earth's surface so that its radiations may not reach the people outside. In fact, so powerful these radiations have proved to be that mice exposed to much weaker radiations perished within a few hours. The operator of the cyclotron is protected from its rays by specially constructed insulating walls. The introduction of the interlocking system of controlled operation protects the equipment from accidentally being damaged by mistakes in operation, or by failure of any component part of the cyclotron. Another device for avoiding accidents consists in providing master switches in the doors, leading to the powerful high-voltage parts of the laboratory, in such a way that the opening of any of these doors automatically results in the cutting off of all power. Thus, accidental entry into the laboratory while the power is on does not prove fatal.

It required four years to build the new cyclotron. The total cost of erection, including its appurtenances and the special three storey building to house the equipment and workshop, has been estimated at $500,000.

NEW HORIZONS

We welcome the appearance of the new illustrated monthly *New Horizons* published from Allahabad under the editorship of Mr Satyendra Nath Sanyal. It is a variety journal and contains feature-articles on topical subjects, short stories, light essays, humorous sketches and entertaining discussions on fashion, femininities and such other topics as satisfy popular curiosity and interest. The printing and the quality of the paper, especially the latter, are good, and we hope the journal will appeal to a wide circle of popular readers.

SCIENCE IN INDUSTRY

A NEW SOIL STABILIZER FOR WATERPROOFING OF ROADS

A NEW resin compound derived from pine resin has been developed in U. S. A. for water-proofing the soil and is being used extensively for speedy construction of military roads and airports. It has been named "Stabinol", since by this method the top 6 inches of the surface soil is being stabilized, so that there is no mud formation. The treated soil does not allow rain water to penetrate the soil, water simply being drained off from the top, and the subsoil water also cannot rise because the chemical treatment upsets the natural phenomenon of capillary action. It is a dry powder and is spread over the surface of the soil by hand or by mechanical sprayer and harrowed to the depth required. The amount of Stabinol required varies with the depth of the soil to be treated and with the chemical and physical properties of the particular soil, as well as with the severity of the exposure to be encountered. In fact, its use has varied from 6 lbs. per square yard for a compacted depth of 6 inches for heavy military roads to 1½ lbs. per sq. yard for playgrounds. On the average, it is reported, the Stabinol required is one percent of the soil treated.

N. K. S. G.

INDUSTRIAL APPLICATION OF HIGH VACUUM TECHNIQUE

THE industrial application of high vacuum technique is of very recent date. High vacuum has proved an extremely useful technique in the dehydration of foods and drugs, production of vitamins, refining of certain chemicals and oils and the distillation of a large number of compounds, such as oils, fats and waxes, otherwise liable to decomposition. Important as its application in these various manufacturing processes has been, it is only in the case of magnesium metallurgy and dehydration of penicillin that high vacuum technique has been applied on a really large industrial scale. The manufacturing processes depending for their success on the use of high vacuum technique generally involve the maintenance of a pressure of about 0·001 mm. or 1 micron, which is equivalent to reproducing the vacuum conditions of the ionosphere inside the plant. The instances of the extraction of magnesium and the dehydration of penicillin, which formed the subject of an interesting note by Richard S. More in *The Scientific Monthly*, may be cited to indicate the difficulties and the advantages attending the industrial application of high vacuum technique.

High vacuum is an indispensable factor in the extraction of magnesium. It accelerates the reduction of the ore into the metal and the evaporation of the magnesium molecules and further prevents its oxidation. Bricks of crushed dolomite and ferro-silicon, contained in a chrome-nickel-steel retort, are heated in vacuum to 1100°C when magnesium is vaporized and condensed in the water-cooled end of the retort. The whole process requires about eight hours. The entire system has to be kept air-tight and maintained at a pressure of 1 micron. At such a low pressure a volume of gas at normal atmospheric pressure expands to 160,000 times its volume, and such huge volumes of gas require to be continuously removed. To this has to be added the volume of occluded gases liberated at low pressure. The amount of gases so liberated may be realized from the fact that at atmospheric pressure a piece of metal contains occluded gases of many times its own volume.

Maintenance of high vacuum under these circumstances has been rendered possible by the use of 'new-type industrial diffusion pumps, together with associated vacuum valves, gauges, and similar parts, capable of exhausting tremendous quantities of air and other gases in record time.' The entire vacuum system claims to have a pumping capacity of several thousands of cubic feet per minute in the micron gauge.

The vacuum technique has been applied with great success to the problem of drying penicillin and has removed the disadvantages invariably associated with the freezing methods of dehydration. The formation of heavy ice layers in the compartments designed to collect the vapour is a serious objection to the latter method. Since enormous volumes of water vapour are continuously liberated, the maintenance of high vacuum presents no small difficulty. The technical difficulties are reported to have been solved by handling air and water vapour independently in the vacuum system with different pumping methods.

It is of interest to note that in U. S. A. the credit for perfecting the vacuum technique as applied to magnesium metallurgy and dehydration of penicillin on a large scale uniquely goes to the National Research Corporation in Boston, which built up the first pilot plant for the extraction of magnesium and developed the High Vacuum Diffusion Process for the drying of penicillin.

CHARCOAL BRIQUETTES AS SUBSTITUTE FOR COAL IN LOCOMOTIVES

INDIA'S deficiency in good coking coal needed for her metallurgical industries is well-known to our readers. In fact, her estimated reserve of coking coal, as was shown in a number of articles in the past issues of "SCIENCE AND CULTURE" (Vol. 7, Nos. 3 & 4), can hardly feed her smelting industries for another 60 years. In complete disregard of this serious deficiency, thoughtless use of good quality coal for purposes other than metallurgical, such as steam raising in locomotives, is being continued, specially when inferior coal after some processing can be used with comparable success. Even the use of charcoal briquettes as a probable locomotive fuel is on record, and we may particularly draw the attention of our readers to a recent article in *Nature*, (July 8, 1944) in which Dr H. Greene and T. N. Jewitt, of the Agricultural Research Institute, Anglo-Egyptian Sudan, have described their own experience with charcoal briquettes as locomotive fuel.

Charcoal briquettes to be successfully employed as locomotive fuel must satisfy certain properties. The briquettes must be very strongly bound as they are required to withstand the severe conditions within the locomotive fire box. Weak binding may lead to loss of fuel due to forced draught and shaking and clinker formation at high temperatures. The authors in their experiments used charcoals available in the central Sudan and generally made from three kinds of acacia, namely *A. Arabica* Wild. (ash content 3--5 per cent), *A. Seyal* Del. (ash content 5—11 per cent.), and *A. Mellifera* Benth. (ash content 6--15 per cent.), of which *A. Seyal* Del. appears to be the most promising and satisfactory source. Charcoal of the above description was finely ground and mixed with pitch (Mexphalte *D.H.* 75/85) which is considered essential for such briquette making. Gum arabic was used as a primary binder. The mixture was stamped into briquettes by three impacts from a 75 lb. weight falling from a height of 6 ft. When such briquettes were hardened on drying they could bear crushing loads up to 2,000 lb. per sq. in. The strength of the briquettes generally depends on several factors, such as gum content, grinding method, number of impacts etc., and the authors obtained strongest briquettes from a mixture containing 60 parts of water to 100 parts of dry matter.

For successful operation the briquettes must give rise to considerable volume of volatile matter. Charcoal-pitch briquettes prepared in the way described were not as such capable of producing the required amount of volatile matter, but were made to do so by dipping them in furnace fuel-oil. The process, however, means some reduction in the mechnical strength of the briquettes, but it is somewhat compensated for by their increased resistance to rain, which this process makes possible. One set of charcoal briquettes made in this way and later subjected to a number of full-scale fuel trials had the following percentage composition: charcoal, 75; pitch, 8; oil, 8; gum, 4; water (lost at 105°C.), 4.

Results of trials with briquettes of this type are recorded in the article. The charcoal-pitch briquettes were used in service trains running at moderate speeds in which normal steam pressures of 170-175 lb. per sq. in. were maintained. The results are reported to be satisfactory. It was found that success in all these trials depended markedly on the ability to grind charcoal to a suitable powder. The results steadily deteriorated with the use of coarser material. Charcoal ground in edge-runner mills produced satisfactory results, but charcoal pulverized in beater type mills developed cracks and internal strains and gave poor results. It is interesting to note that such strains were reduced to a minimum when the charcoal was wetted before grinding. In fact, following this method authors produced strong and mechanically sound briquettes from charcoal which was ground by a type of bull-drawn roller specially designed for the purpose, and edge runner mills were not necessary.

In the making of such briquettes pitch is essential, as attempts to prepare them without the use of pitch ended in smoke. Clinker formation is, however, a great disadvantage which at present militates against the free use of charcoal-pitch briquette as a locomotive fuel. The clinker formation is largely due to impurities, such as siliceous matter, which always contaminate dirty charcoal. Its elimination does not seem impossible, and there is a fair chance of coal being largely replaced by charcoal briquettes in locomotives in the days to come, particularly in countries unfavourably placed with regard to the supply of coal.

METHANE FOR PETROL

A REPORT in the *Chemical Age* places on record the increased use of methane in place of petrol as a motor fuel in Sweden. Although methane does not appear to be a very convenient source of fuel to handle, Sweden had to explore all the possibilities for exploiting this waste gas because of her serious scarcity in coal and petrol. The gas is obtained from sewage, and in 1943, the sewage disposal plant of Stockholm produced over 1 million cubic metres of methane gas. During the present year, the plant has undergone further extensions, and the production is expected to increase by about 30 per cent. Buses and other automobiles are already operating in the cities with great success, and its use is being increasingly welcomed. One cubic metre of methane is reported to be almost equivalent to one litre of petrol as motor fuel and is produced at a cost of 25 öre *i.e.*, 3½*d.* which is about the same as the pre-war price for 1 litre of petrol in Sweden.

STORAGE AND PRESERVATION OF FOOD GRAINS

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THE important question of the great damage done by insects to stored food stuffs and such other commodities has so far received little thought in this country. It is seldom realized in India that due to want of any good system of storage, a large part of the produce of the land is destroyed by insect pests. These pests attack all kinds of stored products, such as paddy, rice, pulses, wheat, flour, tobacco, dried fruits etc. In this way millions of rupees are lost annually.

DAMAGE CAUSED BY INSECTS

It is said that the damage caused by insects in North America costs annually £200,000,000, that the amount of food-stuffs lost annually as the result of the depredations of insects amounts to £60,000,000, and that the damage caused annually by clothes moths, carpet beetles and other insects which attack silk, wool, furs, feather and other articles of animal origin amounts to £20,000,000. It has been estimated that the loss in maize in the State of Virginia in 1922 due to the Angoumois moth, *Sitotroga cerealella*, amounted to between £100,000 and £500,000. In Germany, the annual loss due to the Mediterranean flour moth, *Ephestia Kuhniella*, is estimated between £25,000 and £50,000. About 15 per cent of the stored grains in New South Wales is lost annually mainly on account of *Sitophilus* (Calandra) *oryzae*. The annual loss of cigars due to *Lasioderma serricorne* in Manilla is said to amount from 3,000 to 65,000 dollars per factory. These figures will suffice to show the great losses which mankind suffer through insects. Indeed the losses are so great that they can not be properly estimated.

INSECTS RESPONSIBLE FOR THE DAMAGE

The insects which are commonly found in association with different kinds of stored produce in this country are:—

Beetles: (1) *Tenebrio molitor*, (2) *Orzaephilus surinamensis*, (3) *Sitophilus oryzae*, (4) *Araecerus fasciculatus*, (5) *Bruchus pisorum*, (6) *Tribolium castaneum*, (7) *Tribolium confusum*, (8) *Lasioderma serricorne*, (9) *Trogoderma granarium*, (10) *Rhizopertha dominica*.

Moths: (1) *Plodia interpunctella*, (2) *Corcyra cephalonica*.

Tenebrio molitor, the meal worm beetle, generally infests meal and flour. It is bred in large numbers as food for cage birds. The eggs are laid singly or in small batches. They are prolific breeders and one female may lay 576 eggs during her life time. The larva is of a bright yellow colour, is omnivorous in its tastes, and generally feeds on anything it comes to find. They breed in large numbers during the rainy season. The larvae of meal worms are very resistant to starvation and may live for from 6 to 9 months without food. *Tenebrio molitor* is widely distributed all over the world and are found in all places where food grains are stored.

Orzaephilus surinamensis is known as saw-toothed grain beetle. It is a small brown beetle, has a flat body which is well adapted to its habits of crawling into cracks and crevices. *O. surinamensis* is found all over the world and is an important granary and storage pest. The female generally lays one to four eggs daily and nearly 300 eggs are laid by her during her life.

Sitophilus oryzae is generally associated with rice and is widely distributed in the warmer parts of the world. The larva feeds on rice, forming a winding tunnel which increases in length as the larva grows. In addition to rice, it also infests the common grains such as millets, oats, peas etc.

Araecerus fasciculatus: is found on coffee, biscuits, nutmegs etc., while *Bruchus pisorum* is found in association with peas and lentils.

Tribolium castaneum, the rust red flour beetle, is not so common as *T. confusum* which is found in stored cereals and the products made from them. It is also found in flour, bran etc. The complete life history takes from 50 to 90 days depending on the temperature and humidity. The larvae do the most damage but the beetles also feed on the preserved food.

Lasioderma serricorne attack cigarettes and cigars etc. The eggs are laid in crevices and wrinkles of a tobacco leaf. The life history from egg to the adult lasts from 70 to 90 days. The adult is found wherever tobacco is grown and manufactured.

Trogoderma granarium is a serious pest of stored wheat and barley and is occasionally found in other stored food stuffs. India is its home, from where it was imported with Indian barley into the British Isles, and it has now established itself in breweries even where Indian barley is not used.

The most advantageous conditions for the life history of this beetle are found in hot, dry weather in the Punjab during the months of May, June and and part of July. The beetle is very active during these months and during this time the life history may only last twenty five days. When the beetle meets adverse conditions it becomes dormant and remains so until favourable conditions appear. It can hibernate in the larval stage. The larva has a hairy body and it attacks the grain in a characteristic way. It nibbles at the pericarp and then at the grain. The greatest amount of damage is caused in the top part of the stored grains where the beetle and their larvae are generally found.

Rhizopertha dominica is a cosmopolitan species and is generally regarded as a serious pest of stored grains in India under certain conditions. It lays a large number of eggs, multiplies rapidly under favourable conditions and destroys grains rapidly. It can withstand dry conditions better than can other grain pests. It has been pointed out that it only infests grain in vessels made air tight and never attacks grains in gunny bags and vessels with loose covers. It attacks rice, wheat, barley, beans, lentils etc.

Plodia interpunctella is known as the Indian meal moth. Though it prefers dried fruit, it is commonly found in association with beetles attacking other kinds of stored products. It is cosmopolitan in distribution.

Corcyra cephalonica is also a cosmopolitan species, and is best adapted to live in a warm humid atmosphere. In India, its larvae have been recorded commonly from husked rice and biscuits.

Britain's Effort in conserving Food Reserves

Since food conservation is of such vital importance especially during war time every effort has been made by Britain to minimize the danger of the destruction of food grains stored in godowns. At the onset of the present war His Majesty's Government in Great Britain visualized the possibilities of the loss of the nation's food reserves by this means and a commission was immediately appointed to harness all scientific knowledge of the life and habits of insect pests in different types of grains and also in different industries with a view to preventing the loss. Their report was published in 1940. Its most important result is the demonstration that infestation occurs throughout all the industries producing, housing, transporting, trading in, or using cereals and cereal products. A nation-wide storage system co-ordinated by a national control body under the Ministry of Food was thereafter inaugurated. This has entirely controlled any great increase of vermin in warehouses and food factories especially now when they are handling larger stocks of food. This control body has qualified biologists, mycologists and zoologists of wide experience in industrial biology at the head. This body tackles control of rodents, chiefly rats and mice, control of insects, and moulds and bacteria. They make regular inspection and look into methods of checking infestation. This body also studies the usefulness of different vermin poison-baits, fumigants, rat-poisons etc.

When cargoes arrive at a port or warehouse, strict examination is made to see if they harbour any insect pest, and if so, prompt action by the authorities is called for. This has already checked at the ports some that might have become nationally serious. The food supplies are generally scattered and vacant basements of buildings in out-of-the-way towns are used for storing food reserve which are inspected periodically. The survey has proved its value in recognizing and defining the main problems that need to be tackled. Good ventilation, general cleanliness, dry surroundings, segregation of infested consignments and other simple methods of control have yielded results of value. The problem of insecticidal treatment comes to the fore. The cold storage system and equipment have been nationalized so that all resources can be used to the best advantage. The report is very exhaustive and has done good service in stressing risk from insects and rodents and formulating the problems that have to be made when food conservation is of paramount importance. It has been clearly recognized that there is a whole chain of circumstances which require control in stopping the grain destruction of insects during storage.

In the United States, the Bureau of Entomology and Plant Quarantine have published concised information for avoiding trouble from insects in stored foods.

Insect damage to stored food is increased by long storage. Infestations which were small and negligible once may develop into tremendous proportions within a short time. The rate of multiplication varies in different insects, but the most important underlying factors which favour rapid multiplication are optimum temperatures and humidity.

Food cannot be stored anywhere and every where. If possible, the building must be so constructed as to make it air tight. The idea is that the insects are not only prevented from gaining entrance but that, if infestations occur, such buildings should be readily fumigable.

Insects which infest food materials are generally of minute size. These not only hide in cracks and crevices but may also breed there. The floor and walls must, therefore, be insect proof.

Both Heat and Cold utilized for Preserving Grains

The recourse to adverse temperatures and humidity which have often deleterious effects on the life and multiplication of insects has been widely employed in preserving grains and cereals.

High temperatures of around 140°F do not as a rule affect the quality of most stored products, rice and tobacco being the chief exceptions, nor do they impair the germinating powers of seeds. It is never advisable to go beyond the temperature known to be fatal to the insect pest that is being controlled. The difficulty in high temperature treatment is to decide upon the range of temperature non-injurious to the seed but fatal to the contained larvae and eggs. It is for this reason that the use of heat for controlling insect pests is mainly confined to the treatment of cotton seed against Pink Boll worm, and of flour mills in U. S. A. and Canada against the various pests of flour and grain.

After once the preliminary cleansing has been effected, cold storage at very low temperatures is perhaps the best known method of storing food stuffs under artificial conditions. Although tobacco infested with *Lasioderma* beetles can be easily cured by exposure to 140°F in a steam chamber for half an hour, but it makes the tobacco extremely brittle. For this reason tobacco is disinfested by exposure to a temperature of minus 3 to 4 degrees for several days.

Different Fumigating Agents

The only radical method of ensuring the destruction of insects in the stored products is by fumigation. Hydrocyanic acid gas and carbon bisulphide have long been the favoured fumigants, but within recent years, new materials have come into more or less extensive use, chiefly because these are safer to human life.

Hydrocyanic acid gas, though extensively used as a fumigant, is not so practicable a sterilizing agent owing to a certain lack of penetrative power. This difficulty can be overcome to a great extent if a partial vacuum be created within the container. This method has been adopted by the Federal Horticulture Board of U. S. A. for the sterilization of baled cotton coming from India and Egypt where the Pink Boll worm is present.

The most important factor governing the efficiency of fumigation is adsorption—adsorption of the gas on the walls of the warehouses, on the floors, on the packing cases or sacks, and in the goods themselves. It is highly important, therefore, that one should know how fumigants are adsorbed, what residues are left and how far these can be removed by ventilation or airing in the first instance and by industrial processes later. Therefore, in the treatment of edible materials, though only a very small amount of the fumigant is adsorbed, this must be without danger before it can be safely used. Cotton seeds exposed to the action of hydrocyanic acid gas under reduced pressure retain a considerable quantity of this gas owing to the solubility of hydrocyanic acid in the oily seed content. This is not wholly expelled by exposure to air. On the other hand this gas has no deleterious effects on flour, grains etc.

Carbon bisulphide is a clear volatile liquid and has a smell resembling chloroform. It is a very heavy liquid and is comparatively non-toxic but it is extremely inflammable and is liable to explode. Its successful application requires a warm atmosphere, not less than 70°F, and an exposure varying from 30 minutes to one or two days.

In order to cure infestation in the house, small quantities of the seed or grain may be treated in a barrel or an iron container by pouring the liquid directly on to the grains. One ounce of carbon bisulphide is necessary to sterilize 100 pounds of seed and within 36 hours the treatment is complete.

Unlike carbon bisulphide, carbon tetrachloride is not inflammable and is often used in fire extinguishers to smoother flames. This property makes this gas an extremely safe insecticidal fumigant but its toxicity to insects is relatively low. It is generally combined with ethylene dichloride and the combination has been reported as highly effective. It has also often been used to blanket the carbon bisulphide but in the proportion in which blanketing is effective and fire and explosion risks are negligible, these two vapours or gases generally separate out, and this leads to patchy distribution and patchy kill of the insects.

Fumigation with formaldehyde is laid down as the standard method to be adopted in the Regulations for the Army Medical Services. Formalin is placed in a galvanized iron pale, chloride of lime wrapped in thin paper, which is then pierced, being quickly added. A violent chemical reaction immediately takes place, 80% of the formaldehyde being vaporized by the heat of the primary reaction. Insect eggs are rendered sterile when exposed to this gas for 24 hours.

Napthalene is volatile and is insoluble in water. When placed in a closed chamber, it readily saturates the air. It is not only an insecticide but is also a good insect repellent. Its use is limited to conditions where the food has been stored in an air-tight chamber.

If the moisture content is reduced to less than 7 per cent, it will ensure the destruction of *Calandra* beetles, and according to the report by the Australian Commonwealth Advisory Council of Science and

Industry, such dry storage of sundried wheat will make it possible to store this produce indefinitely without damage from weevils. In case flour has to be stored by this process, the moisture content must be reduced from 10 to 14 per cent to less than 7 per cent by subjecting it to some drying process. In the same way other food products, like maize, can be easily stored for a long time.

Napthalene in proportion of 1 lb to 2,000 lb, when placed in muslin bags and suspended from the top, can be effectively used for storing maize, rice, paddy, wheat, seeds etc. The napthalene should never be mixed with the grain, as airing for even 2 days will not remove the odour.

Chloropicrin (nitrochloroform), this material known during the first world war as tear and vomiting gas, is prepared by adding an aqueous solution of picric acid to an excess of bleaching powder. It has been found to be of considerable application as an insecticidal fumigant. It is extremely toxic to insects and is less toxic to human beings than carbon bisulphide. It is non-inflammable and can penetrate commodities when stored in bulk. It has no action on metals and fabrics and colours are not affected. It has also a pronounced lachrymatory effect, so that its presence can be quickly detected. It has recently been found that it acts better when combined with carbon dioxide than when it is used alone in a pure state. Though it is widely used in U. S. A. and France, it should be remembered that it is liable to impair the germination power of seeds unless they are dry.

Ethylene dichloride is another fumigant. This material although synthesized from ethylene, does not contain an ethylene linkage, the formula being $CH_2\ CL-CH_2\ CL$. This should not be confused with dichloroethane. It is a colourless liquid, non-corrosive to metals and at ordinary temperature is not dangerously inflammable. It possesses an odour similar to that of chloroform. A mixture with carbon tetrachloride in the proportion of 3 : 1, is an effective fumigant and is relatively safe.

The use of trichloroethylene is known. The pure material decomposes readily when exposed to light, yielding phosgene and hydrochloric acid. It can only be used when mixed with ethylene dichloride. Tetrachloroethane has not been much used as a fumigant for stored products.

Ethylene oxide possesses marked insecticidal properties and can penetrate deeply. Its disadvantages are that in certain concentration this gas, like carbon bisulphide, is combustible and explosive when mixed with air. When mixed with carbon dioxide in a ratio of 1 part of the former to 7·5 parts of the latter by weight, it is non-inflammable and the mixture does not separate or stratify. The addition of carbon dioxide increases the insecticidal value of ethylene oxide to a marked degree.

The mixture of ethylene oxide and carbon dioxide is now known by the trade name of carboxide. It is non-injurious to fabrics, furniture or food products and is little toxic to man. Some insects of stored products are much more quickly affected by this mixture than hydrogen cyanide. It affords an additional advantage as it leaves a residue in fumigated products of no toxicological significance. But it should be remembered that where seeds are concerned ethylene oxide may seriously affect their germination.

Cyclohexene oxide has been patented in U. S. A. for disinfestation of stored products but apparently has not been tested on a large scale.

Methallylchloride is a product manufactured from petroleum hydro-carbons and is a liquid which evaporates easily at normal temperature. This material no doubt possesses good insecticidal qualities but at the same time it is a skin irritant. Too little is yet known of its decomposition products and its reaction with food to justify its extensive use at this stage.

Trichloroaceto-nitrile is lachrymatory ; it is probably widely used in Germany and has a number of unpleasant features, the chief being that it is an insidious poison. Its penetrative properties are satisfactory. It is slightly corrosive to iron and steel.

Acrylonitrile is toxic to insects in the gaseous stage. It is miscible in all proportions with carbon tetrachloride ; a 1 : 1 by volume mixture is non-inflammable. This mixture has approximately the same effectiveness on insects as the acrylonitrile alone. Wheat fumigated with this agent should be aerated before milling.

Provided the storage container is air-tight, liquid carbon dioxide may be employed to kill all insect life including eggs within a short time. Even if the carbon dioxide is not introduced from outside, the carbon dioxide which is produced both by grain and insects acts as a narcotic. Aided by the diminished oxygen pressure brought about by the grain absorbing oxygen, this gas has a toxic effect upon the weevils. If the exposure is prolonged, the power of germination becomes impaired. Otherwise this method can be considered as ideal.

The use of methyl bromide as a fumigant for the control of insect pests has increased markedly within the past few years. It is a highly potent fumigant and is effective in causing death of nearly all types of insects, including their eggs, that infest stored products. It compares favourably with hydro-cyanic acid gas, chloropicrin, and ethylene oxide in its toxicity to insects. The amount of methyl bromide (determined as bromide) absorbed during fumigation varies with the nature of articles fumigated, but is

generally decreased after exposure to air. Milled grains have considerable power to adsorb the fumigant and fatty articles absorb more than non-fatty ones. The small amount of methyl bromide residues left on the fumigated stuff is unlikely to be harmful to the consumer, but laboratory experiments have shown definite pathological changes in the internal organs of rabbits receiving high concentration of methyl bromide in olive oil over a prolonged period.

Irrespective of the nature of the agent that is selected, this process to keep grains free from insects by fumigation is expensive and for this reason it can only be practised successfully in places like mills and large Government stores and is totally impracticable of being carried out in the household and in the farmhouse.

Contact Insecticides

For commercial stored products the most commonly used insecticide is one that contains pyrethrum. Pyrethrum, whether used in the form of a dust or in the liquid state mixed with some non-odourous mineral oil, is fatal to all types of insects which possess a well-developed tracheal system. Even the eggs are also quickly affected. It also leaves a residual effect which can be made use of to protect the produce in the warehouse from being reinfested during the period when such insects are very active, especially during the rainy season. The dry powder can also be advantageously mixed with the grains as pyrethrum is toxic only to insect-life and not to higher animals.

Pyrethrum-oil sprays are, therefore, used extensively in flour mills, bakeries, wholesale groceries and many other places where foods are made or stored. The dissipation of the odour is usually complete within an hour after spraying.

The use of ordinary hydrated lime has been recommended to protect peas.

Sprays containing aliphatic thiocyanates are reported to make effective warehouse and mill sprays. Lethane 384 is an American discovery which has recently been placed on the market. It is an insecticide concentrate designed specifically as the active agent of a liquid insecticide. It belongs to a class of compounds known as aliphatic thiocyanates, the elements entering into the composition of these compounds are carbon, hydrogen, oxygen, sulphur and nitrogen. No elements which are basically poisonous are involved in its composition. It is non-toxic to human beings in small quantity, but exceedingly toxic to all forms of insect life. A mixture with stainless kerosene in proportion of 1 : 5 forms an effective insecticide for application in warehouses.

In outlining the destruction of stored food grains by insects we have intentionally left out the part insects play where they interfere with the activities of farmers and agriculturists such as the great ravage done by migratory locusts.

Method Applicable to India

In India, by the Destructive Insects and Pests Act of 1914, there is a general prohibition against the importation of any article liable to infest any crop. By a further Government Order of 1917, no plant is to be imported to British India except fruits, vegetables, and sugarcane unless sterilized with hydrocyanic acid gas at one of the specified ports.

It will be noticed from the above that the fumigating agents which can be used for destroying insect pests in stored food are of a varied nature and, though each presents some particular characters in its favour, for ordinary purposes the choice will lie among hydrogen cyanide, ethylene oxide, carbon disulphide and chloropicrin. The use of chloropicrin in England is not, however, recommended by the Ministry of Health.

For all round use in this country a mixture of ethylene oxide and carbon dioxide is recommended. It has no harmful effect either on the operator or upon the food-stuffs fumigated. It is only when it is present in high concentrations, that it causes irritation to the eyes.

Fumigation cannot be successfully performed in warehouses, factories, mills etc., particularly in India, because of the difficulty in rendering the building gas-tight and also in procuring the necessary equipment. Besides, the high cost involved in its execution will be a great discouraging factor. This difficulty can be readily obviated by using any contact insecticide, such as pyrethrum and derris derivatives and synthetic thiocynate compounds. Disinfestation by contact insecticides will be particularly suitable especially when the bulk to be treated is not very large and where the container has frequently to be opened as in shops and in households. But when the bulk is large, cold storage will be the ideal method of preserving grains, cereals and dried fruits. A temperature of 40° to 45°F is inimical to most insect life.

Present day scarcity of Pyrethrum

The greatest drawback to the wider use of any vegetable insecticide lies in the fact that derris in the pre-war days came from the Far East and pyrethrum mainly from Japan. A reduced production of pyrethrum flowers in Kenya Colony in East Africa, induced by drought conditions and the increased use of this commodity in the army's aerosol insecticide programme have resulted in a practical stoppage of pyrethrum allocations to normal peacetime consumers. Other than in most exceptional

cases, no exports have been permitted from U. S. A. in over a year ; pyrethrum household fly sprays have received no allocations both in U. S. A. and India under the present emergency, and use in livestock sprays, an important use in milk production, was excluded in U. S. A. last spring. Small quantities have been granted to some pest control operators doing essential public health work, but with scrutiny as to usage and earlier allocation. The American army itself has foregone the use of pyrethrum in military establishments and instead is using synthetic substitutes for all insect control other than malarial mosquito work and this only in field and jungle. It is thought that the scarcity of pyrethrum is to be expected for an indefinite period.

We thus find that we will have no choice left but to use thiocyanate compounds which all come from America and for which we must be prepared to pay high costs.

Need for Research

To cope with the tremendous damage done by insects, the individual will always look to the State for guidance and advice. Without adequate knowledge of the life and the habits of the attacking insects it is impossible to formulate any rational measure of control. As far as the entomological part of the subject is concerned, the chief requisites are a familiar aquaintance with the common injurious insects and especially a thorough knowledge of their life histories. The latter may be considered as a foundation of the whole structure of economic entomology. In order to attack an enemy we have to know its weakest point and also the conditions favourable for its growth, multiplication and dispersion.

While the knowledge of the habits of insects provided by the entomologists is of considerable interest, it would be of little value without the co-operation of the chemist who provides the lethal weapons necessary for their destruction and produces new and more effective remedies.

MEDICINE AND PUBLIC HEALTH

A NEW ANTI-BACTERIAL SUBSTANCE

The discovery of a new anti-bacterial substance, called chlorellin, resembling penicillin in its action, has been announced in *Science*, April 28, 1944, by a group of twelve scientists working on this problem. The substance is produced from a very common one-celled fresh-water alga known as chlorella, from which the new substance derives its name. The investigating scientists used cultures of two species of this lowly plant, *Chorella vulgaris* and *Chorella pyranoidosa*. Masses of the cells were grown in five-gallon tanks and then filtered off. The remaining water was then chemically treated to extract whatever compound might have been left in it. Chlorellin was obtained in the extract, and in the crude condition it appeared as a brown stuff, sometimes tacky and gummy, sometimes hard and brittle.

Trials with chlorellin in solution on test cultures of several kinds of bacteria clearly indicated its bacteriostatic action against such organisms as streptococcus and staphylococcus. In this respect it resembles penicillin closely. It has been further suggested that, unlike penicillin which is only bacteriostatic, chlorellin may actually kill the germs.

The extracts thus far obtained are crude, and large-scale production and the practical use of this anti-bacterial substance in medicine are yet to be made possible by further researches. The most interesting fact about chlorellin is that it is found in a green plant able to manufacture its own food out of natural raw materials. All previously discovered compounds, including penicillin, are made from moulds, soil bacteria, and other plants which require to be supplied with ready-made foods in the form of glucose solutions and the like.

CAUSE OF CANCER

Recent studies by Dr Konrad Dobriner and Col. C. P. Rhoads, of the Memorial Hospital, and by Dr S. Lieberman, Dr B. R. Hill and Dr L. F. Fieser, of Harvard University, seem to favour production line trouble in the body's endocrine glands, particularly the adrenals, as a probable cause of both cancer and leukaemia. The results of these studies have been recently reported at the Atlantic City meeting of the American Society for Chemical Investigation, according to *Science News Letter*.

The basis for such a view is the newly observed fact that kidney excretions of cancer patients contain chemical substances which are not found in the excretions of normal persons. Furthermore, there

exists a marked difference in the amounts of certain hormone chemicals excreted by normal persons and by cancer and leukaemia patients. The glands of such patients are supposed to produce cancer-causing chemicals instead of harmless chemicals they should have normally manufactured. The glands involved may be sex glands or the adrenal glands or both. Faulty function of the cortex of the adrenal glands is particularly suggested. These evidences seem to be in agreement with the recent observation of Dr James B. Murphey, of the Rockefeller Institute, that the development of transplanted leukaemia in rats could be prevented by injections of adrenal cortical hormone.

UNITED NATIONS RELIEF AND REHABILITATION ADMINISTRATION

Report of the Sub-Committee on Policies with respect to Health and Medical Care

[The first session of the Council was held at Atlantic City, New Jersey, U. S. A., from November 10 to December 1, 1943. Forty-four countries including India, signed the Agreement. Mr Dean Acheson, Assistant Secretary of State of the U. S. A. was the Chairman of the first session. Sir Girija Shankar Bajpai represented India. In all, 47 resolutions were adopted. Four main Committees, with several sub-committees, were formed to discharge the functions of the Council. We shall present the readers today with the Report of the Sub-Committee on Policies with respect to Health and Medical Care. In the next issue we propose to publish the Report of the Sub-Committee on Policies relating to Agricultural Rehabilitation and other means of raising food essential to relief.—Ed. *Sc. & Cul.*]

Scope of the Health Work of Unrra

THE health work will necessarily constitute one of the primary and fundamental responsibilities of the UNRRA. The relief and rehabilitation programme must aim toward the maximum of health security within the practicable limits of the resources of the United Nations.

This programme would consist chiefly of the provision of assistance to governments in the rapid re-establishment of their health services, generally preventive and curative. These services include not only disease control and relief from malnutrition, but also the re-establishment of medical services, hospitals, dispensaries, sanitoria, health centres, laboratories, environmental sanitation, maternity and child welfare services, the control of endemic diseases, particularly tuberculosis and venereal diseases, and other essentials for health. For this purpose UNRRA should be prepared to give assistance in connection with equipment and supplies, personnel, expert advice, facilities for technical training, and the collection and dissemination of information bearing on the above problems.

One of the aims of UNRRA should be *to equalize opportunity* for the restoration of health in the various countries. This will involve a sharing of responsibilities and equitable distribution of goods and other assistance in proportion to need and in accordance with a co-ordinated plan.

Among the most important functions of the Health Organization of UNRRA will be work in connection with the control of epidemics, particularly those affecting more than one country. Early examination will have to be made of the best method of collecting, analyzing and collating such reports regarding epidemics as may be available from any source including such information as the military may find it possible to furnish, and subsequently distributing this information for the use of member governments as well as UNRRA itself.

Furthermore, the Health Organization will sponsor promptly the conclusion of emergency agreements among the various governments establishing uniformity in the quarantine measures to be observed among them. In addition, the Health Organization will seek to co-ordinate the steps taken by countries mutually concerned in the control of outbreaks of infectious diseases. Moreover, UNRRA may be called upon to provide urgently needed medical supplies for meeting an emergency. In view of the obvious importance of dealing rapidly with epidemics, it is essential that the Health Organization has at its immediate disposal trained personnel and material.

The Health Organziation may be called upon to provide for the loan of experts to various countries, particularly in cases where diseases have been introduced for the first time as a result of the war, and with the control of which neither the National Health Authority nor the local practitioners are familiar, or where diseases, already endemic have reached epidemic proportions.

The medical aspects of nutrition will constitute one of the chief preoccupations of the Health Organization which will be urgently concerned with the provision of nutritional standards adequate for the

maintenance of health in the territories in which it operates.

The Health Organization in collaboration with the member governments concerned will play an extremely important part in the health supervision and control of returning displaced persons. In this connection it will be important to co-ordinate the health measures taken in the country of departure, the countries of transit, and, if the government concerned so desires, in the country of distinction.

The special health needs of children and expectant and nursing mothers must be given early recognition by the Health Organization. Prompt and adequate provision for the health and nutrition of these vulnerable groups is essential to the restoration of normal family life and community stability.

The problems of health among orphan children will be acute and must be dealt with in close collaboration with other functional units of UNRRA. Special measures will be required to deal with communicable diseases among all children, particularly those who are lowered by malnutrition. This may well be intensified by over-crowding, and the lack of clothing and of other essentials for health and normal development.

Although it may be necessary at the outset to deal with the health problems of mothers and children through group arrangements, including maternal and child health clinics, feeding stations and other emergency provisions, yet as soon as possible, such care should be individualized to meet the needs of each. The Health Organization should participate in the development of UNRRA plans for providing food for these special groups in order that food policies may be maintained in consonance with their special physiological needs.

The Health Organization may also be called upon by member governments to assist in dealing with the conditions of anxiety, fear and emotional disturbances which will have arisen in peculiarly great frequency among the children and youth of occupied territories.

A constant objective of the health programme should be to demonstrate the effectiveness and need for international collaboration in public health. In so doing it will facilitate the later development of a permanent world-wide health organization.

Policies with Respect to Governmental and Non-governmental Health Organizations—Relationships with National Health Service.

It is the duty of national health services to assume full responsibility for public health within their countries and UNRRA should assist in the effective prosecution of these activities directed to this end whenever this is requested by a member government.

Whenever possible the national and local health services should be the channel through which the health work of relief and rehabilitation operations are carried out, and it should be a constant objective of the Health Organization to assist in strengthening these services.

Collaboration between Member Governments in the Control of Epidemic Diseases

Since diseases are not limited by political boundaries, member governments must collaborate fully in the joint adoption of measures designed to control the international spread of disease especially through the exchange of epidemic intelligence so far as military security permits, joint action in connection with the health aspects of repatriation of displaced persons and where necessary direct collaboration between their national health services. Such necessary co-ordination and combined action could best be arranged by the creation of a special section in the Health Organization of UNRRA for epidemiological control.

Co-operation with Governmental International Health Agencies

Co-operation with existing governmental international health agencies should be fostered. The Health Organization of the League of Nations, the industrial health section of the International Labour Office and the Pan-American Sanitary Bureau have much to offer on the basis of their long experience and accomplishments. In view of the importance of nutrition from a health point of view, co-operation should be sought with the Interim Commission established by the United Nations Conference on Food and Agriculture, and with any permanent organization which may succeed it. Co-operation with the International Public Health Office in Paris is, of course, out of the question at the present time.*

Co-operation with Non-governmental Health Agencies

The wide experience and goodwill of the non-governmental health agencies should be utilized to the utmost as it is clear that the full participation of all such agencies may well be needed. In accordance with the terms of the Agreement, plants and policies should be developed whereby the resources of such organizations may be used effectively in those health aspects of relief and rehabilitation in which they have special competence.

* Paris was under German occupation at the time when the report was submitted. With the liberation of Paris, the question of co-operation with the International Public Health Office in Paris may be revived.

General Functions of the Health Organization

The general functions of the Health Organization should include:

(a) responsibility for the health aspects of all the work of UNRRA;

(b) assembling of comprehensive data on the health and medical organization of the various countries, including information on hospitals, dispensaries, health centres, laboratories, sanitary installations and scientific institutions; the numbers and kinds of local technical personnel; and the local production and distribution of sanitary and medical supplies.

(c) collection of information on health conditions in the various territories, including data on epidemic diseases, nutrition, sanitation, maternal and child health, tuberculosis and other diseases, the care of the sick and physically handicapped, the local production and distribution of medical and sanitary supplies and all related matters;

(d) over-all estimation of the amounts and kinds of medical and sanitary supplies needed, and the arrangement for their procurement, allocation, transportation and distribution;

(e) recruitment of technical and professional personnel, establishment and conduct of training programme, assignment of personnel to specific fields of operation, and the general direction of health operations in the field;

(f) preparation, in collaboration with the respective member governments, of plans for health relief and rehabilitation for specific countries;

(g) where consistent with UNRRA policy and within the general framework of its field operations, temporary general administration of health services in areas where national or local health services are not yet functioning effectively;

(h) responsibilities in connection with the health of displaced persons;

(i) preparation of recommendations to the Council or to the governments concerned for any emergency international agreements necessary to control the spread of disease;

(j) provision of experts or expert teams at the request of a national government;

(k) assistance in the control of epidemics;

(l) carrying out of the general health policies of UNRRA in relation to co-operation with the health service of the appropriate inter-Allied military authority; international governmental health agencies; international and national non-governmental health agencies; and other Divisions of UNRRA engaged in activities related to the health field, especially food and agriculture, welfare, and displaced persons.

Policies Regarding the Health Organization of UNRRA

The re-establishment of health being one of the principal objects of relief work, it is essential that the status of the Health Organization should be commensurate with its importance in the work of the whole administration.

It is a recognized principle of administration that all work of a technical character be carried out under technical directions. In view of the fact that almost every aspect of the work of UNRRA will necessarily have health implications (programming, supplies, personnel, training, co-operation with governments, field operations, etc.), the Director of Health must be accorded a position in the administration which will enable him under the authority of the Director General, to develop suitable policies and to exercise proper technical direction over all health aspects of the work of UNRRA.

The Health Organization should consist of a Director of Health and a technical and administrative staff, a standing technical Committee on Health of the Council which would be advisory to the Council, to the Central Committee, and to the Medical Director, and the necessary regional organization. Experience has shown that a considerable degree of decentralization is desirable in health administration, so that strong regional organizations will be needed in areas such as Europe and the Far East.

Director of Health of UNRRA—There should be in the administration a health organization with a Director of Health, who should be accorded a position in the administration, which will enable him, under the authority of the Director General, to develop suitable policies and to exercise proper technical direction over all health aspects of UNRRA.

Acting under the authority of the Director General, the Director of Health would be responsible for the health and medical aspects of all UNRRA activities. He would be directly concerned in all major policy and administrative decisions in which health, medical, or nutrition problems are involved. It follows that the status and success of UNRRA from the health point of view depend on obtaining the services of a Director of Health of the highest possible professional standing, whose previous work is such as to command the respect of those qualified to judge, both from a technical and administrative point of view.

Regional Health Directors.—A Regional Health Director should be appointed to each Regional Organization; his position should be relatively similar to that provided for the Director of Health.

Executive Health and Secretarial Staff.—The greatest care will be required in selecting health personnel for field work in the various countries. Technical competence is fundamental, but almost equally important is the ability to work in a team with others of a different nationality as the staff will necessarily include health personnel from a number of countries. This qualification is of primary importance for members of the staff required to work away from Headquarters, for they must be able to understand the outlook of the people among whom they are called upon to work. In comparison with this quali-

fication, a knowledge of languages, though a valuable asset, is of secondary importance.

During and immediately after the war, it will be by no means easy to find health personnel who possess such divergent capacities. In order to enable UNRRA to obtain promptly the necessary staff, the various member governments should facilitate the secondment or otherwise make available health personnel both from central and local health authorities, including short-term appointments.

Field Missions.—The organization of health missions and the constitution of individual missions should be the responsibility of the Director of Health or the Regional Directors of Health, acting under the authority of the Director General.

With regard to the field organization, however, it is impossible to anticipate what types of individual or special missions may be required. Member governments may well ask for highly technical assistance in almost any branch of medical or sanitary science, particularly in view of the isolation of many of their own experts during the years of war. The Health Organization of UNRRA should, therefore, collect information regarding individual experts and expert teams which might be made available for service in the field should the occasion arise.

Standing Technical Committee on Health.—A standing technical Committee on Health should be appointed as provided for in the Agreement. For efficient work the number of members should be limited to between 9 and 15. Chairmen of the Regional Health Sub-Committees should be included in the membership of the standing Technical Committee on Health. As the Agreement provides that the Council can appoint as members of the Committee on Health alternates of special competence in their respective fields of work, it is urged that members should nominate the Committee alternates technically capable of aiding in the deliberations of the Committee. It is of the greatest importance that such alternates as are nominated be accredited as representatives of their respective Public Health Services.

Regional Health Sub-Committees.—Since experience has proved the desirability of a considerable degree of decentralization on health administration, particular attention should be paid to the setting up of strong Regional Health Organizations including Regional Health Sub-Committees. Undoubtedly the Regional Health Sub-Committees consisting of from 9 to 15 members sdould be made up of accredited representatives of the national health administrations concerned. The importance of such representation is obvious in the case of epidemics involving more than one country, for these circumstances success in preventing the spread of the epidemic will involve combined action by the several health administrations concerned.

Both the central standing Technical Committee on Health and the Regional Health Sub-Committees should make it a practice to involve the participation of representatives of the health services of any countries in meetings at which important measures directly affecting such countries are discussed.

Expert Commissions.—In view of the highly technical character of the health work of UNRRA it will be essential for the standing Committee on Health and any Regional Health Sub-committee to have authority to appoint expert commissions. The members of those expert commissions should be nominated as individuals and solely on the ground of their special knowledge of the subject concerned. As members of expert commissions speak as individuals only, there is no necessity to make any such commission even approximately representative of a number of countries, except so far as this may be necessary in order to get a balanced representation of several schools of scientific thought. National and administrative views would be representated by the standing Technical Committee on Health and the Regional Health Sub-committees, and it is for this reason, among others, that recommendations of experts or expert commissions should invariably pass through the Committee on Health or the Regional Health Sub-committee, as the case may be, before their final acceptance.

Among others, expert commissions on nutrition will be required which, in view of the wide differences obtaining in the food habits and nutritional status between various parts of the world, might be regional in character. These experts would deal with the scientific and physiological aspects of the nutrition problem and would give advice in connection with any proposed alterations in the constitution of rations, the priorities of special rationing and the classes of the population requiring special consideration, *e.g.*, expectant and nursing mothers, infants, cases of tuberculosis, deprivation diseases, etc.

Consideration should be given to the constitution of an expert commission dealing with the health of mothers and children which might be related to comparable groups of experts dealing with other aspects of maternal and child care.

Conference of Directors of National Public Health Services.—Provision should be made to enable the Director of Health under the authority of the Director General and with the approval of the Council to summon, either centrally or regionally, a conference of Directors of National Public Health Services whenever practicable and desirable.

Immediate Tasks of the Health Organization

The tasks calling for immediate action include:

(a) Selection of a Director of Health, and the recruitment of a competent staff, utilizing the full resources of the United Nations so far as they can be made available at the present time.

(b) Immediate provision of help upon request of any member government in order to meet emergency health problems which have actually arisen as the result of the war.

(c) Collection and assembly of all information available on those areas likely to be liberated first and scientific data which may be of value to the Health Organization.

(d) Conferences with appropriate Health Officials of the member governments concerned with regard to the nature and amount of assistance that may be required of UNRRA.

(e) Recruitment and training of personnel for field missions.

(f) Study and collection of previously prepared estimates of health, medical, and sanitation supplies, and arrangement for their scheduling and procurement, with emphasis upon the importance of rapidity in forward procurement particularly in respect of supplies required for the control of epidemics.

(g) Collaboration with the Allied Military Authorities for the collection of information regarding the existing conditions in liberated areas, the prevalence of epidemics and the arrangements for the orderly transfer of any health responsibility to UNRRA, where this is so requested by the member government or the Military Authorities themselves.

(h) Training of nationals of the various countries in special medical and allied technical work. Whilst facilities have already been made available in connection particularly with training in the making and fitting of artificial limbs, training in the use of mass radiography apparatus, laboratory technical assistants, etc., yet it is felt that this service should be greatly increased so as to cover a much wider scope in order to provide the technicians who will be required for medical relief work immediately a country is liberated; for this purpose it would be desirable for some governments to assign certain of their nationals for training, and for others to offer facilities for such training.

(i) Obtaining of medical literature dealing with the progress of medicine and hygiene during the years of war for the liberated countries. For this purpose the Health Organization of UNRRA should give immediate consideration to the possibility of collecting selected periodicals on the various branches of medical and sanitary science.

Even though it may not be possible for UNRRA to meet all the relief and rehabilitation needs of the populations affected by the war, nevertheless by approaching the tasks through the wise use of the technical resources of the United Nations, mobilized and engaged in the same spirit of co-operation as they are now devoted to the prosecution of the war, it should be possible, in the public health sphere, to attain comparable success in the war against disease and for the restoration of health.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

MEASUREMENT OF H. F. MAGNETIC SUSCEPTIBILITY OF LIQUIDS AND SOLUTIONS BY HETERODYNE BEAT METHOD

Though heterodyne beat method is extensively used in experimental determinations of the dielectric constant of solutions and liquids at high frequencies, it has been tried and found inconvenient for the measurement of their h.f. magnetic susceptibility. Recently, however, several workers[1,2] have successfully used this method to measure the h.f. susceptibility or permeability of magnetic substances in form of thin wires. When these wires are introduced into suitably designed inductances of the oscillatory circuits, changes in beat note is observed and original conditions are restored by adjusting the value of the calibrated variable condenser in the circuit. From the knowledge of the change in capacity required to get the original condition and the dimensions of the wire and inductance h.f. susceptibility of the wires may be easily calculated. In case we want to measure the h.f. susceptibility of liquids or solutions, they must be introduced into the inductance, in tubes of much greater diameter than that of wires, in order to get any appreciable effect. This will, however, produce considerable electrostatic capacity between the inductance and the experimental liquids and the inductance effect may be obliterated. In order to eliminate the capacity effect, Belz[3] used inductances wound over glass tube which was thinly coated (thickness of the order of 7×10^{-6} cm.) with

platinum, the latter being connected to the earth. The inductance was thus electrostatically completely shielded from inside. The selection of platinum and extreme thinness of the film were necessitated by the fact that the coated conductor should not reduce the magnetic field of the inductance by any appreciable amount. If H_0 is the intensity of the magnetic field of the inductance at the surface of the conductor and H_t the corresponding value at a depth t inside the mass then $H_0/H = e^{-\frac{\sqrt{2\pi\mu p}\,t}{\sigma}}$, where, μ and σ represent the permeability and specific resistance respectively of the conductor and $p=2\pi n$, n being the frequency. For platinum $\mu=1$, $\sigma=11{,}000$ c.g.s., e.m.u. and if $n=4\cdot84\times10^5$ per sec. (as used by Belz) within the shield for $t=7\times10^{-6}$ cm., $H_t/H_0=0\cdot9997$, that is very nearly equal to unity. It may be seen that if higher frequencies are used the ratio will recede further from unity and the variation of the magnetic field due to appreciable absorption by the shield is bound to introduce errors in the experiment.

The present authors, while carrying out experiments on the measurements of the h.f. magnetic susceptibility of solutions and liquids, have devised an arrangement which appears to be quite effective in shielding the experimental liquids from the electrostatic influence of the inductance and is much more convenient and easily manipulated. The arrangement consists of a double walled glass tube,—the annular space being filled with a non-magnetic solution like KCL or NaCl solution and connected to the earth. The width of the annular space is about 1 mm. The inductance wire is coiled on the outer tube and the inner one contains the experimental liquids. For a solution of NaCl used by us σ was found to be $14\cdot2\times10^9$ c.g.s. e.m.u. and here $H_t/H_0=0\cdot9714$ even for a wave length of 100 meters ($n=3\times10^6$ per sec.) and for a thickness of the liquid (forming the shield) equal to 1 mm. It is unnecessary to discuss here the difference in the procedures and calculations between cases when wires or solutions in thin tubes are used from those in which solutions in wider glass tubes are employed.

B. N. SINGH
LALIT PRASAD

Physics Laboratory,
Science College,
Patna, 3-8-1944.

[1] Wait, G. R., *Phy. Rev.*, **29**, 566, 1927.
[2] Wait, G. R., Brickwedde, F. G. and Hall, E. L., *Phy. Rev.*, **32**, 967, 1928.
[3] Belz, M. H., *Phil. Mag.*, **44**, 479, 1922

HOW TO MANURE A POND FOR FOOD OF FISHES

IN order to manure a pond for food of fishes one may put bundles of dried straw tied with a string round them in the tank, so that at the time of need these bundles may readily be removed without scattering. Such dry bundles of straw in water make a suitable medium for culturing protozoa[1] like *Paramoecium, Vorticella, Colpoda* etc. Dried water-hyacinth or pistia may be put in the same way in water of the pond in order to get a culture of minute crustacea like *Daphnia.*[2] Stable refuse or kitchen refuse has the effect of culturing both algae and protozoa. Sewage water also accelerates the growth of algae more rapidly than anything else. So that by gradually adding some quantities of sewage or stable refuse in a pond, the water could be turned green. This green colour indicates that no more such manures need be added. Putting cowdung or mustard-oil-cakes in the pond renders the growth of algae, protozoa and crustacea. In addition to the above mentioned articles of food of fishes all these manures assist in the excessive growth of aquatic higher plants which also form, not in fresh condition but when they are transformed to a state of semi-rotten condition[3] the main bulk of food of adult herbivorous fishes.

Now the question is whether all the above processes of manuring ponds justify, when we know that nearly 95% of our ponds in Bengal are kept for the purpose of procuring drinking water as well as for pisciculture. If that be so, we ought to take every precaution and should not advocate manuring of ponds by stable refuse, kitchen refuse or sewage water which renders the water of the ponds unfit for drinking purposes. This will do more harm than good.

In order to have the desired culture of algae we can take the recourse of having algae culture in *gamlas* with Knop's or Moore's solution. Dried straw or dried water-hyacinth may not pollute water if given in minute proportion, but it is desirable to have the protozoa and crustacea culture in *gamlas* so that after their culture they may be transferred to ponds for further multiplication. So it comes to this, that there are two sets of ponds (1) ponds for the purpose of pisciculture only, (2) ponds for the purpose of both pisciculture and drinking water. For the first set of ponds we can use stable refuse, kitchen refuse or even sewage water and also dried bundles of straw or water-hyacinth directly in the water of the pond, as for the second set of ponds we ought to be very cautious about pollution of water. We should use salts for culture of algae, dried straw or water-hyacinth for protozoa and crustacea either in *hundies* or *gamlas* to be ultimately transferred to ponds.

Every pisciculturist ought to remember that for the sake of fish we cannot pollute our drinking water.

H. K. MOOKERJEE.

Zoology Department,
Calcutta University,
7-8-1944.

[1] *Calcutta Review*, 84, No. 3, 1942.
[2] SCIENCE AND CULTURE, 9, 558, 1944.
[3] SCIENCE AND CULTURE, 9, 306, 1944.

SULPHANILAMIDE DERIVATIVES FOR THE TREATMENT OF INTESTINAL INFECTION

SULPHAGUANIDINE, sulphapyridine, succinylsulphathiazole and phthalylsulphathiazole[1] have been found to be useful in the treatment of bacillary dysentery and other intestinal infections. Stovarsol (3-acetylamino-4-hydroxyphenylarsonic acid), which has been reported to produce favourable effects in the treatment of amoebic dysentery, is not entirely innocuous.

In order to obtain a drug which may prove effective both in amoebic and bacillary dysentery, 3 - *p*-acetylaminobenzenesulphonamido)-4-hydroxyphenylarsonic acid, m.p. 168-170° (decomp.) (found: N, 6·21 ; As, 17·60. $C_{14}H_{15}O_7N_2SAs$ requires N, 6·51 ; As, 17·42 per cent) has been obtained by condensing *p*-acetylaminobenzenesulphonyl chloride (1 mol) with 3-amino-4-hydroxyphenylarsonic acid (1 mol.) in presence of aqueous solution of sodium carbonate (1 mol.). On hydrolysis of the above compound with 10 per cent hydrochloric acid and subsequent treatment of the hydrochloride with sodium acetate, 3 - *p*-aminobenzenesulphonamido)-4-hydroxyphenylarsonic acid, m.p. 182-183° (decomp.) (found: after drying *in vacuo* at 110°, N, 6·79. $C_{12}H_{13}O_6N_2SAs$ requires N, 7·21 per cent.) has been obtained, the pharmacological examination of which is under investigation.

S. L. LASKER
T. N. GHOSH

Bengal Immunity Research Laboratory,
Calcutta, 7-8-1944.

[1] Poth and Ross, *Proc. Amer. Soc. Pharmacol. Feder. Proc., Baltimore*, 12, 89, 1943.

THE EFFECT OF QUININE SULPHATE SOLUTION ON *HYDRA VULGARIS*, PHASE *ORIENTALIS*

THE effect of different strength of solution of toxic substances like quinine, strychnine, nicotine and venom on some protozoons has been studied by a few workers (Kriz[1] ; Philpott[2] ; Chopra and Chowhan[3 a, b] ; and Sarkar[4]). But, so far I am aware, no one has studied the effect of such substances on any Coelenterate material. The object of the present communication is to record my observation on the effect of the different strengths of quinine sulphate solution on *Hydra vulgaris*, phase *orientalis*.

Different grades of quinine sulphate solution were prepared in distilled water for each set of experiments. Three sets of experiments were carried out with three Hydra in each set and their average death time are noted below (Table 1).

TABLE I

Serial Nos. of experiments	Strength of the solution	Minimum death time	Maximum death time	Mean death time
I	1 in 1,000	9 min.	12 min.	10·5 min.
II	1 in 1,500	12 min.	16 min.	14 min.
III	1 in 2,000	1 hr. 15 min.	1 hr. 30 min.	1 hr. 22·5 min.
IV	1 in 2,500	1 hr. 25 min.	1 hr. 30 min.	1 hr. 35 min.
V	1 in 3,000	1 hr. 30 min.	1 hr. 55 min.	1 hr. 42·5 min.
VI	1 in 5,000	2 hr.	2 hr. 35 min.	2 hr. 37·5 min.
VII	1 in 10,000	6 hr. 30 min.	7 hr.	6 hr. 45 min.
VIII	1 in 25,000	10 hr. 30 min.	12 hr.	11 hr. 15 min.
IX	1 in 50,000	26 hr.	29 hr.	27 hr. 30 min.

From the above table it may be observed that there is a sudden leap of the average death time from 14 minutes to 1 hour 22·5 minutes in the experiment No. II to III.

It may be noted that all the Hydra died within certain definite periods according to the different strengths of solutions used by me. But before their ultimate death the organisms showed some reactions in their movements and behaviours in different strength of the quinine sulphate solution. It is well known that when Hydra comes in contact with any foreign object it at once contracts its body. But soon after it shows the natural relaxation of its body. In the present experiments Hydra contracted at the first instance when they were transferred into the solutions of quinine sulphate from water, but the subsequent relaxation of their bodies disappeared *pari passu* with the gradual increase of the strength of the solution.

In the natural state Hydra is found to attach itself by its base to some foreign object. In the aquarium it is found to attach even to the walls of the vessel. When Hydra were introduced into the watch glass containing the quinine solution upto 1 in 10,000 (Experiments Nos. I to VII) they never

tried to attach their bases to the surfaces of the glass. But after the introduction of the Hydra into the solution of 1 in 25,000 (Experiment No. VIII) they attached their bases to the surface of the watch glass after some time. This shows that Hydra can withstand toxic effect of quinine sulphate solution from 1 in 25,000 onwards.

In all experiments it was observed that just at the time of death the whole body assumed the shape of a bell and floated in the solution upside down. The tentacles were the organs which first manifested signs of paralysis. Later on, the tentacles gradually gave away to maceration, the body remaining intact and showing signs of life. Still later, the anterior part of the body began to macerate and when the body was allowed to stay in the solution for a sufficiently long time a complete dissolution of the whole body took place. This shows that the effect of the solution operates on the tentacles first and then gradually pervades on the body ; even then the discharged nematocysts of the tentacles and of the body remain unaffected in the fluid.

The reactions and behaviours of Hydra in different grades of solutions may be summarised as follows:

(1) Hydra can withstand the toxic effect of the solution from 1 in 25,000 onwards.
(2) The tentacles are first paralysed, then general maceration of the body follows.
(3) The discharged nematocysts remain intact in the solution even after complete maceration.

This work was carried out in the Department of Zoology, Cotton College, Gauhati, Assam. My best thanks are due to the College authorities for the facilities given to me for the work.

H. L. SARKAR

Department of Biology,
Vidyasagar College,
Calcutta, 17-8-1944.

[1] Kriz, R. A., *Amer. Naturalist*, **58**, 464-69, 1921.
[2] Philpott, *Proc. Soc. Exp. Biol. Med.*, **26**, 522-23, 1928-29.
[3] (a) Chopra, R. N. and Chowhan, J. S., *Ind. Jour. Med. Res.*, **18**, 1103-11, 1931.
(b) Chopra, R. N. and Chowhan, J. S., *Ind. Jour. Med. Res.*, **20**, 1, 1932.
[4] Sarkar, S. L., *Archiv Protistenkunde*, **87**, Ht. 2, 268-71, 1936.

EFFECT OF SOLAR ECLIPSE ON THE IONOSPHERE

A series of ionospheric measurements were made with the ionosphere apparatus at the University College of Science, Calcutta (lat. 22° 33′ N, long. 88° 22′ E) during the solar eclipse of July 20, 1944.

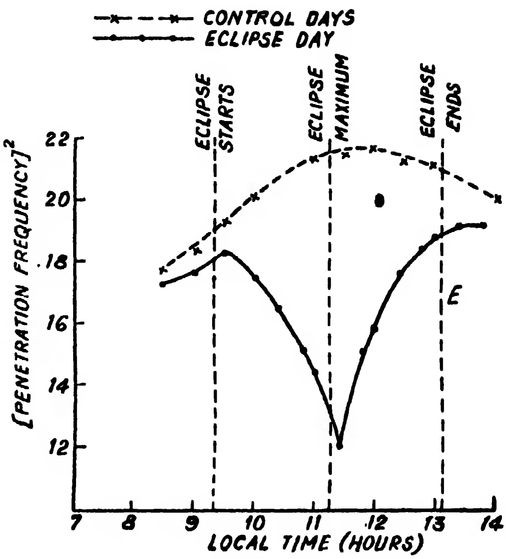

FIG. 1.

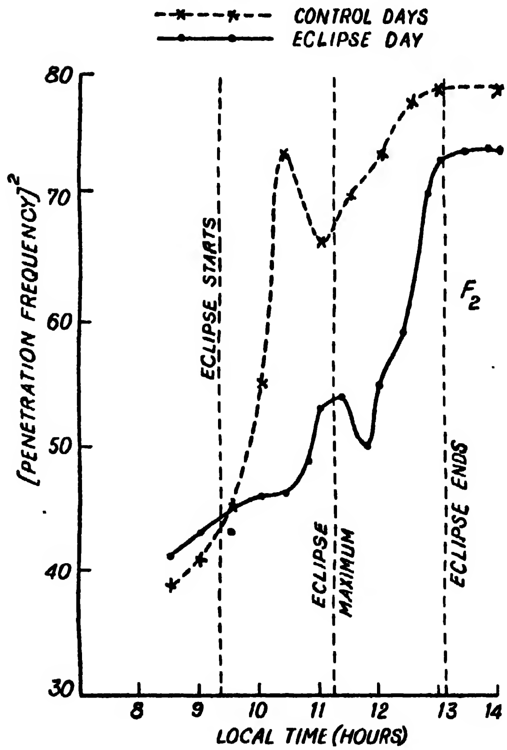

FIG. 2.

FIGS. 1 and 2. Depicting the variation of ionisation during the eclipse period. The broken line curve represents the average variation of the square of the critical penetration frequency with time for the six control days—three days before and three days after the date of the eclipse, July 20, 1944. The full line curve represents the ionisation variation on the day of the eclipse.

The eclipse, as observed at Calcutta, was a partial one. At the instant of maximum obscurity 87·5% of the sun's disc was covered. Variations of the penetration frequencies of Regions-E and F_2 were made with the progress of the eclipse. The measurements were started one hour before the commencement of the eclipse and were continued at intervals of about 20 minutes up to one hour after the eclipse was over; the observations were made more frequently about the middle of the eclipse. Observations were also made 3 days before and 3 days after the eclipse during the same local hours to check the average condition of the ionosphere.

The variation of ionisation of both the regions was found to be quite normal on the control days. On the day of the eclipse, during the hours preceding the start of the eclipse the ionisation of Region-E was found to be slightly less and that of Region-F_2 slightly greater than the average ionisation as recorded from the control observations. With the progress of the eclipse, however, the ionisation of both the regions fell below the normal values. For Region-E the ionisation decreased smoothly and the minimum was attained 10 minutes after the eclipse maximum. The minimum of ionisation was about 43% below the normal value. For Region-F_2 the maximum decrease observed was 30% and it occurred 14 minutes after the eclipse had reached its maximum.

Fig. 1 depicts the sharp minimum in the ionisation of Region-E. For the case of Region-F_2 (Fig. 2) however, the minimum is not as marked as in the case of the Region-E, though the ionisation is found to be depressed appreciably below the normal value during the eclipse period.

The observations were undertaken at the suggestion of Prof. S. K. Mitra and the authors take this opportunity of thanking him for providing facilities in the Ionosphere Laboratory to carry out the observations.

S. S. Baral
S. N. Mitra

Wireless Laboratory,
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Calcutta, 7-9-1944.

COEFFICIENT OF RECOMBINATION OF $N_2^+(X')$ IONS AND ELECTRONS IN THE AFTER-GLOW OF ACTIVE NITROGEN

According to the hypothesis of active nitrogen recently proposed by Mitra[1] the positive ions of $N_2^+(X')$ disappear in the volume of the gas by a process of three-body collision in course of which the first positive bands, the characteristic spectra of the after-glow are emitted. The coefficient of recombination process can be calculated if the rate of decay of the glow is known (when the wall effect is minimum).

Lord Rayleigh,[2] in his extensive series of measurements on the variation of brightness of after-glow under different experimental conditions, has made quantitative measurements of the rate of decay of after-glow of active nitrogen when the wall effect is minimum. In the present note these data are used to compute the coefficient of recombination. The data (p. 5, ref. 2) are as follows:

Time (secs.)	0	2·4	4·2	6·4	9·8	22·4
Candle power of glowing gas	1·06	·359	·203	·090	·051	·013

To calculate the coefficient we note that if n be the number of positive ions or electrons per c.c. (assuming the two to be same) and if each recombination of positive ion and electron is assumed to give one quantum, then the number of quanta q emitted per c.c. per unit time will be, $q = \alpha n^2 = \frac{dn}{dt}$.

Here α = coefficient of recombination and is independent of n. From the above it is easy to show that $\frac{d}{dt}(q^{-\frac{1}{2}}) = \sqrt{\alpha}$. This means that if we plot $q^{-\frac{1}{2}}$ against t the curve will be a straight line and its slope will give $\sqrt{\alpha}$.

Let us take, after Rayleigh, the mean wavelength of the after-glow light, in the region of its maximum luminosity to be λ5560. Each emitted quantum has therefore the energy $h\nu = 3{\cdot}57 \times 10^{-12}$ erg. Remembering that 1 candle power $= 2{\cdot}02 \times 10^5$ erg per sec. and that the volume of the gas was 19 litres, we can calculate q corresponding to each of the values (candle power) given in the second row of the table. Plotting $q^{-\frac{1}{2}}$ against t we find that the points lie very closely on a straight line. The slope of the line is 2×10^{-7}. Hence $\alpha = 4 \times 10^{-14}$ cm 3/sec.

My attention to the problem was drawn by Prof. S. K. Mitra for which I am thankful to him.

J. S. Chatterjee.

Wireless Laboratory,
University College of Science,
92, Upper Circular Road,
Calcutta, 7-9-1944.

[1] Mitra, S. K., Science and Culture, *9*, 49, 1943-44; *10*, 133, 1944; *Nature*, *154*, Aug. 12, 1944.
[2] Rayleigh, *Proc. Roy. Soc.*, *A*, *176*, 1, 1940.

Indian Science News Association

PROCEEDINGS OF THE NINTH ANNUAL MEETING

THE Ninth Annual General Meeting of the Indian Science News Association was held on September 9, 1944 at 5-15 P.M. in the hall of the applied Chemistry Department at the University College of Science, Calcutta.

In the absence of Dr S. C. Law, President of the Association, Prof. P. N. Ghosh, Vice-President was in the Chair.

Before the business of the meeting was begun all assembled stood in silence as a mark of respect to Acharyadeb and Prof. B. B. Ray.

The proceedings of the last annual meeting were read and confirmed.

On behalf of the Secretaries Prof. S. K. Mitra submitted the following report of the working of the Association and the audited accounts for the year 1st July, 1943 to 30th June, 1944.

Annual Report

The Council of the Indian Science News Association have much pleasure in submitting this, the Ninth Annual Report and the Statement of Accounts for the period July 1, 1943 to June 30, 1944.

Obituary

Before we proceed I would like to refer to the losses sustained by our Association through the hands of death. During the period under review we lost Sir P. C. Ray, our most revered benefactor, who had been a source of inspiration to us since the inauguration of the Association. He showed his sympathy for our work in the most practical way by making handsome donations to our funds whenever we were in difficulties. The Editorial Board of SCIENCE AND CULTURE has undertaken the publication of an authoritative biography of the late Acharya and this in the least that the Association could have done to show its gratitude. His memory is cherished by our countrymen, but we, in particular who have special reasons to be grateful pay our respectful homage to his hallowed memory on the occasion of this Annual Meeting of ours.

We also lost recently Professor B. B. Ray, one of the founder members of the Association and one of the first Editors of SCIENCE AND CULTURE. The Association when started in 1935 had no room of its own, and Professor Ray allowed his sittting room to be converted into office for SCIENCE AND CULTURE. He gave his time and energy freely to the service of the magazine which needed fostering care in its early days. Professor Ray's memory will remain fresh in the minds of his colleagues and co-workers, and the Association mournfully records the help and services it received from him.

Membership

During the last year, *i.e.*, 1943-44, 8 new members joined the Indian Science News Association as compared to 14 in the previous year.

The number of life members at the close of the year under review was 110 compared to 103 on the corresponding date last year showing an increase of 7.

Science and Culture

The total number of copies of *Science and Culture* despatched in June, 1944, the last month of the period was 1127 as compared with 1041 in the same month in 1943. The number of subscribers in June, 1944 (including members of the Association) was 954, which represents an increase of 101 since June, 1943. The actual number of new subscribers enrolled was however 104.

We had difficulties owing to scarcity of paper and, in the absence of high quality paper, we were forced to print the journal on inferior paper. Our thanks are due to Mr Raghunath Dutt of Bholanath Dutt & Sons Ltd., who supplied us regularly with paper.

During the year 1943-44 authoritative articles from the pens of specialists were published and the high standard of the journal was maintained. We would take this opportunity of thanking our contributors who by their articles, notes and letters have helped SCIENCE AND CULTURE to step in the Tenth year of its existence.

Exchange Journals

The total number of copies sent out every month in exchange and for review was 62. We received in exchange only 6 English, 14 American, 20 Indian and 1 Australian journal as compared to 4 English, 13 American, 17 Indian and 1 Australian journal in

the previous year. We also received journals of learned societies and publications of 4 Government Scientific Departments. Four Calcutta newspapers, viz., the *Statesman*, the *Hindusthan Standard*, the *Amrita Bazar Patrika* and the *Jugantar* supply their daily issues in exchange. The well known Madras daily the *Hindu*, has also been recently added to the list. We send the journal regularly to 18 Societies and Institutions on request.

ADAIR, DUTT RESEARCH FUND

We are glad to announce that the well known firm of Messrs Adair, Dutt & Co. Ltd. has placed at our disposal a further sum of Rs. 2,500/- for award as research scholarships. Last year 4 new scholarships were awarded, and 2 scholarships were renewed. The scholars are:

NEW SCHOLARS

	Name	*Subject*	*Under whom research to be carried*
1.	Mr Govinda Ram Debnath	Androgenic Hormones (Chemistry)	Prof. J. K. Chowdhury, Dacca University.
2.	Mr Arobinda Nath Bose	Processing of foodstuffs on vitamin values (Higher Technology)	Prof. B. C. Guha, Calcutta University
3.	Mrs Amina Rahman	Methods of estimation of the vitamin of the "B" Group and their assay in Indian foodstuffs (Nutrition)	Prof. B. C. Guha, Calcutta University
4.	Mr Amal Chand Ghosh	Cyclotron work (Higher Technology)	Prof. M. N. Saha, Calcutta University

RENEWALS FOR THE SECOND YEAR

1.	Mr Satyendra Nath Ghosh	Measures of the intensity of the night sky (Physics)	Prof. S. K. Mitra, Calcutta University
2.	Mr Sailendra Nath Ghosh	Feeding in Carps (Zoology)	Prof. H. K. Mookerjee, Calcutta University

We have much pleasure to announce that a further sum of Rs. 3,000/- has been contributed by the above mentioned firm to the fund for carrying on researches in other subjects to be decided by the Committee.

(*For statements of account see page 4*).

GRANTS

We are grateful to the authorities of the University of Calcutta, the Bengal Chemical & Pharmaceutical Works, Ltd., and the Indian Association for the Cultivation of Science for renewing their annual grants. The amounts of these grants are as follows:—

Calcutta University	Rs. 500/-
Bengal Chemical & Pharmaceutical Works Ltd.	Rs. 500/-
Indian Association for the Cultivation of Science	Rs. 100/-

During the year the Association was fortunate enough to receive the following donations. We express our sincerest thanks to the donors.

Sir P. C. Ray	Rs. 2,000/-	
Messrs. H. Datta & Sons Ltd.	Rs. 1,000/-	
Messrs. Soor Enamel & Stamping Works	Rs. 1,000/-	
Mr Alamohan Dass	Rs. 750/-	
Messrs. Calcutta Chemical ...	Rs. 500/-	with further promise.

To the authorities of Calcutta University we are further indebted for allowing us accommodation in the buildings of the University College of Science and Technology.

ACKNOWLEDGEMENT

We owe a debt of gratitude to our subscribers and well-wishers who have helped us in securing new subscribers. We would in this connection mention the name of Dr Maneck B. Pithawalla of Karachi who has secured for us nearly half a dozen subscribers and members.

CONCLUSION

As in the past years the Editorial policy of SCIENCE AND CULTURE continued to be to make every attempt to focuss public attention on the importance of the application of science, scientific research and scientific methods to the social and economic problems facing our country. We were glad to find that Prof. A. V. Hill who was in our midst a few months ago whole heartedly supported the stand taken by us. Like us he was strongly of opinion that the solution of many of our problems lay in wider and still wider application of scientific research, of scientific methods and in proper and scientific approach. Prof. Hill demanded from the country and from the Government ruling the country these very things in regard to which SCIENCE AND CULTURE has been pleading all these years. We may perhaps be pardoned if we quote Prof. Hill on this point from one of his speeches. Said Prof. Hill: "Let us aim at giving 1 per cent. of our national budget, 1 per cent. of the value of our industrial and agricultural production, 1 per cent. of the loss due to ill-health, 1 per cent. of the cost of our food, our transport, our houses, our water, our coal, even our broadcasting, to research—and in 10 years we shall find that we are getting back

not 1 per cent. but 10 or 20 or 40 or 200 per cent. in dividends. . . . . .

"If those who call themselves 'Practical men' object, let us remember Francis Galton's definition of the practical man—'the practical man is the man who practises the errors of his forefathers'."

We may also refer to another aspect of economic development for which SCIENCE AND CULTURE has been preaching since its inauguration and which is now receiving a good deal of public attention. We have recently seen the publication of many "Plans" for the economic regeneration of the country. We have Bombay Plan, People's Plan, Plan for Railway Development, Agricultural Plan and the 300 crores Education Plan. But the fundamental idea lying behind any planning, namely that, planning for forced development to be successful, must be made simultaneously for all the different branches of social and economic life of the country providing correlation between them as necessary, had been stressed in SCIENCE AND CULTURE in many of its articles and editorials. We are also glad to note that the Government of Bengal has officially been recommended to make a thorough survey of the power and economic resources of the province—a survey on the necessity of which also SCIENCE AND CULTURE has been pleading for a long time. Let us hope that the Indian Science News Association, through its organ SCIENCE AND CULTURE, will continue to do the good work it had been doing since its inception in 1935.

(For statement of account see next page)

The following persons were unanimously elected officers and members of the Council for the year 1st July, 1944 to 30th June, 1945:

President.—Sir U. N. Brahmachari.

Vice-Presidents.—Dr S. C. Law, Dr Baini Prashad, Prof. M. N. Saha, Dr B. C. Law, Sir S. S. Bhatnagar and Prof. P. N. Ghosh.

Treasurer.- Prof. P. C. Mitter.

Secretaries.—Prof. S. K. Mitra and Prof. B. C. Guha.

Members.—Prof. S. P. Agharkar, Dr B. Ahmad, Mr H. P. Bhaumik, Prof. D. M. Bose, Mr W. D. West, Dr K. Biswas, Shahibzada M. Yusuf Khan, Col. Sir R. N. Chopra, Dr M. S. Krishnan, Sir J. C. Ghosh, Dr D. S. Kothari, Mr B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Dr John Matthai, Mr M. M. Sur, Prof. P. Ray, Dr S. L. Hora and Dr A. C. Ukil.

The Editorial Board of "SCIENCE AND CULTURE" for the next year was constituted with Sir J. C. Ghosh, Prof. M. N. Saha, Dr A. C. Ukil and two Secretaries as ex-officio members.

Prof. P. N. Ghosh then delivered his welcome address and stressed the importance of the scientific journal SCIENCE AND CULTURE, the organ of the Association.

Among the distinguished speakers were Dr D. M. Bose, Prof. M. N. Saha, Dr Nalinaksha Sanyal, Mr S. M. Bose, Mr H. P. Bhaumik and others. Prof. Saha spoke on the need of inaugurating in India an organization like the P. E. P. in Great Britain and referred to the distinguished services this organization consisting largely of eminent scientists, economists and industrialists of England rendered to their country. A similar organization may also be created in this country to its great advantages to tackle effectively with the problem of economic development of this country. The lurking question of fertilizers, for instance, may form the subject of its immediate enquiry and activity when such a body is created here. He invited the active co-operation of distinguished scientists, economists and industrialists in the matter.

Dr N. Sanyal spoke on the need of co-operation between the Government and the scientists of the country. He deplored the utter lack of such co-operation and the callous neglect of the Government with regard to question pertaining to science. Moreover, expert knowledge on the scientific aspects of several questions is not often available before the legislatures when such questions come up for discussion.

Mr H. P. Bhaumik spoke on the need of power development in this province and referred to the significant advances Madras made in this direction. He suggested the introduction of the well-known grid system for the transmission of power when such stations are brought into existence.

Prof. S. P. Agharkar proposed a vote of thanks to the Chair.

INDIAN SCIENCE NEWS ASSOCIATION

(Registered under Act XXI of 1860)

Receipts and Payments Account for the year ended 30th June, 1944.

RECEIPTS	Rs. As. P.	Rs. As. P.
To *Opening Balances on 1-7-43* :—		
(*a*) At Bengal Central Bank Ltd. in Current A/C ...	1,481 13 9	
(*b*) At Bengal Central Bank Ltd. in Savings A/C. re: Science & Culture A/C.	796 13 3	
(*c*) With Treasurer ...	118 3 6	
		2,396 14 6
,, Grant	...	1,100 0 0
,, Donation	...	4,750 0 0
,, Life-Membership Fee ...	...	700 0 0
,, Ordinary Membership Fee ...	...	305 6 0
,, Subscription	...	4,588 2 5
,, Advertisement	...	5,288 4 0
,, Reprint	...	512 8 0
,, Miscellaneous	...	612 2 0
,, Bank Interest	...	31 3 7
	Rs.	20,284 8 6

PAYMENTS	Rs. As. P.	Rs. As. P.
By Establishment	...	3,170 0 0
,, Journal Printing	...	4,646 1 0
,, Paper	...	3,197 10 6
,, Postage & Receipt Stamp ...	...	657 9 0
,, Conveyance	...	216 10 3
,, Telephone	...	210 13 0
,, Sir P. C. Ray Biography A/c.	...	50 0 0
,, Miscellaneous	...	202 11 0
,, Audit Fee (1942-43) ...	...	40 0 0
,, Furniture	...	108 0 0
,, Stationery & Printing ...	...	154 8 9
,, Bank Charges	...	53 12 0
,, Binding Charges	...	12 8 0
,, *Closing Balances on 30-6-44* :—		
(*a*) At Bengal Central Bank Ltd. in Current A/C. ...	6,353 3 3	
(*b*) At Bengal Central Bank Ltd. in Savings A/C. re: Science & Culture A/C.	1,143 8 3	
(*c*) With Treasurer ...	67 9 6	
		7,564 5 0
	Rs.	20,284 8 6

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of INDIAN SCIENCE NEWS ASSOCIATION (Registered under Act XXI of 1860) for the year ended 30th June, 1944, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said Account is correctly stated in accordance with the books of accounts of the Association.

Sd. S. K. Mitra,
Sd. B. C. Guha,
Honorary Secretaries.

Sd. A. K. Ghosh,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

Sd. P. C. Mitter,
Treasurer.

10, Old Post Office Street,
Calcutta, the 18th August, 1944.

ADAIR, DUTT RESEARCH FUND

Receipts and Payments Account for the year ended 30th June, 1944.

RECEIPTS	Rs. As. P.	Rs. As. P.
To *Opening Balances on 1-7-43* :—		
At Bengal Central Bank Ltd. in Savings A/C. ...	7,940 2 1	
With Treasurer ...	27 14 6	
		7,968 0 7
,, Bank Interest	...	71 0 0
	Rs.	8,039 0 7

PAYMENTS	Rs. As. P.	Rs. As. P.
By Stipend	...	2,400 0 0
,, Advertisement	...	62 8 0
,, Accountancy Charges ...	...	10 0 0
,, Postage and Receipt Stamp ...	...	1 0 0
,, Conveyance	...	12 0
,, *Closing Balances on 30-6-44* :—		
At Bengal Central Bank Ltd. in Savings A/C. ...	5,536 2 1	
With Treasurer ...	28 10 6	
		5,564 12 7
	Rs.	8,039 0 7

AUDITOR'S REPORT TO THE MEMBERS

I have audited the above Receipts and Payments Account of ADAIR, DUTT RESEARCH FUND for the year ended 30th June, 1944, with the books and vouchers and have obtained all the information and explanations I have required. I certify that the said Account is correctly stated in accordance with the books of accounts of the Fund.

10, Old Post Office Street,
Calcutta, the 18th August, 1944.

Sd. S. K. Mitra,
Secretary,
Sd. G. Bhattacharya,
Treasurer,
Adair, Dutt Research Fund.

Sd. A. K. Ghosh,
Government Diplomaed Accountant,
Registered Accountant,
Auditor.

SCIENCE AND CULTURE

A Monthly Journal of Natural and Cultural Sciences

Vol. X NOVEMBER, 1944 No. 5

PRINCIPLES OF REGIONAL PLANNING

THE unique success of the Tennessee Valley Authority (shortly called TVA), a purely administrative body appointed by the U.S.A. Govment to ameliorate the material conditions of a derelict and poverty-stricken region in North America barley ten years ago, has struck the imagination of the world. The example of the TVA will certainly be emulated in many parts of the world, particularly in India, where many regions have gone down in prosperity due to mishandling by men in recent years. A striking parallel is afforded by the Damodar Valley for which a treatment on the Tennessee model has been proposed in the columns of SCIENCE AND CULTURE by Prof. M. N. Saha and Mr K. Ray (Vol. X, No. 1).

But in our opinion, the TVA experiment cannot possibly be repeated with success unless the initiators of such schemes are permeated with the TVA philosophy and TVA spirit. In fact, we wish to issue a note of warning, for almost everyday we read in the papers of pronouncements by highly placed persons of their intention that some project is going to be undertaken in India on the TVA model. But anybody who has read Lilienthal's book will require no arguments to be convinced that the TVA success cannot be achieved by the existing Government machinery* merely by engaging the services of some engineer who has caught the magic by paying a flying visit to the TVA, or by calling some of the TVA men for a short consultation to the affected spot. It requires a complete revolution in the attitude of the Government towards REGIONAL PLANNING and the setting up of a form of Government machinery almost quite unknown in this country.

Let us explain, in Lilienthal's own words, some of the essential principles of TVA. He says:—

> "TVA was initiated frankly as an experiment; it has been administered in the spirit of exploration and innovation. But it is no utopian Brook Firm experiment; not an endeavour to escape into a simpler past (he might have added as in the futile Gandhian experiment with Charka and Khaddar—*Ed.*), or a more romantic future. TVA and this Valley face the facts of the present with all its complexities and difficulties."

We are not quite sure that the administrative principles which brought the TVA into existence had their roots lying deep in the soil of American tradition, as Lilienthal claims. The question was to anyhow to bring the TVA into existence, and this was the great point:

> "It required no change in the constitution of the U.S.A. Congress has maintained full control. Property rights and social institutions have undergone no drastic amendment."

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* The Tennessee Valley Authority was constituted in 1933 by President Roosevelt with an administrative triumvirate of three Directors:—Dr Arthur Morgan, Engineer, Chairman, in charge of construction, H. A. Morgan, Entomologist and Horticulturist specially interested in fertilizer programme, D. E. Lilienthal, a Lawyer with special knowledge of problems of electrical power distribution.. Difficulties arose within the Authority and Dr Arthur Morgan had to leave in 1939. Since that time Dr Lilienthal has been Chairman of the Board. A short account of the technical achievements of the the TVA has been given in an article by M. N. Saha and K. Ray in SCIENCE & CULTURE, (Vol. IX, Pp. 418 (1944)).

The present article is based on a number of books which have recently appeared on the subject. The following may be mentioned:

(1) Adventure in Planning by Julian Huxley, Pp. 142 (Architectural Press Ltd., 1943).

(2) The TVA—A Study in Public Administration by Prof. C. H. Pritchett.

(3) TVA—Democracy on the March by David Lilienthal, Chairman of the TVA.

The first primarily deals with technical achievements; the second is a critical examination of the administrative machinery set up for the TVA. The third is by far the most important, as it is from the pen of one who has been in charge of administrative machinery from the very inception of the Authority, and has unquestionably first hand knowledge and experience of the inner working of the machinery. We have drawn most of our material from the last book.

The key to the act which created the TVA is to be found 'in the oneness of men and natural resources, the unity that binds together land, streams, forests, minerals farming, industry, mankind'. Lilienthal designates it as the first law of Nature: we should designate it as the first principle of exploitation of Nature.

President Roosevelt's message to the Congress urging approval of Senator Norris's bill which brought the TVA into existence is indicative of this spirit. The message reads as follows:

"It is clear that the Muscle Shoals development is but a small part of the potential public usefulness of the entire Tennessee River. Such use, if envisioned in its entirety, transcends mere power development: it enters the wide field of flood control, soil erosion, afforestation, elimination from agricultural use of marginal lands, and distribution and diversification of industry. In short, this power development of war days *leads logically to national planning for a complete river watershed involving many States and the future lives and welfare of millions.* It touches and gives life to all forms of human concerns. (Italics are ours).

"The President then suggested legislation to create a Tennessee Valley Authority—a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general social and economic welfare of the Nation. This authority should also be clothed with the necessary power to carry these plans into effect." (TVA —Democracy on the March).

Could not this work be done by the ordinary machinery of the Government, or by private agencies?

To this question, Mr Lilienthal says a decided no, and we agree with him. To quote his words in a slightly different setting:

"According to custom and tradition, the instrumentalities of the Government in every country become divided into jurisdictional pigeonholes but the resources of a great river valley like the Tennessee are such that they cannot be dissected into separate bits that would fit into these holes. To integrate the many parts of the problem into a unified whole is clearly the work of one agency. For envisioned in its entirety, this river like many other rivers in the world had manifold potential assets."

These are:—

(1) The river can yield hydro-electric power for the use of industries, for the development of mineral resources lying under the soil, and mountains of the valley, for domestic purposes, and generally for the comfort of the dwellers of the valley. These require construction of dams, hydro-electric stations, and powerlines.

(2) The very same dams, when properly designed, can be made to provide channels for navigation.

(3) The river threatened the welfare of the dwellers of the valley by recurrent floods; this could also be remedied by erection of flood holding dams.

(4) The floods of the Tennessee and its affluents used to carry to the sea every year the top-soil of the hills once lined with valuable timber, and of arable fields. Out of nearly nine million acres of cultivable soil in the valley, nearly 80 per cent became useless and sterile due to soil erosion.

This was remedied by planned afforestation of the valley, which, by the way, also lengthened the life of dams by preventing silting.

And there are many others, namely,--fish culture in the lakes, prevention of pollution of river water by industries etc.—all requiring attention from public authorities.

If the work were entrusted to any one of the Government departments, the 'pigeon holes' as Lilienthal calls them—all other work excepting the work in which that department was interested would have suffered. If the whole work was centralized under one Federal Bureau (Central Department of the Government, as we would call them in India) for the sake of co-ordination, no progress would have been made, as such departments are usually saddled with too much work, and could not possibly concentrate on the Tennessee Valley alone.

If power development were entrusted to private agencies, they would have constructed only power dams and would not have cared for improving navigation, flood prevention, or soil conservation. If the work were entrusted to department of Agriculture, probably only trees would have been planted and irrigation canals excavated, without regard to problems of public health or communication.

But what was needed was 'the total benefit to all that was to be the common goal, and this could be achieved only by the appointment of an Authority' clothed with full powers of execution of the objective, on behalf of the Federal Government.

The jurisdiction of the TVA cut across the existing line of Federal Bureaus departments and of the seven States through which the river runs. It threatened to interfere with private rights, with the privileges enjoyed by the existing business concerns (particularly private power supply companies), and the work has not been smooth. Further it was given a task of integrating the works of specialists and technicians in such diverse subjects as power engineering, navigation, soil conservation, flood prevention, and public health, and anybody who has experience of handling specialists knows this to be no holiday job.

It is now admitted on all hands that the experiment of the TVA, in spite of its perilous nature has been a grand success, much of which was due to the flexibility of the bill appointing the Authority, which was given a task, but was otherwise let free to draw up its own programme, fix upon the method of execution of plans, recruit its own personnel, and

carry out the plans to perfection as it thought best. There had been no predetermined blue prints, but the TVA was itself a planning and executing agency, and the plans evolved like a living organism with time and experience and as a result of free and protracted discussions amongst specialists and parties concerned.

A great responsibility was thus thrust on the Board of Directors, and we shall see in our next article how they discharged their responsibilities.

ARTIFICIAL RADIOACTIVE BODIES IN PHYSIOLOGY AND MEDICINE*

N. N. DAS GUPTA

UNIVERSITY COLLEGE OF SCIENCE, CALCUTTA.

WITH the invention of the cyclotron it has been possible to impart radioactive property to every known element. Some of these artificial radio elements, such as C, Na, Fe, P, Ca, I etc., have proved to be of the greatest value in the investigation of physiological problems as well as in medicine. It is the purpose of this brief account to explain the method of preparation of these and also to describe some of the many valuable results brought to light with their help.

The cyclotron can properly be named as the machine for producing nuclear transformations. With its help it is possible to transmute one element into another. Some of these man-made elements are unstable, *i.e.*, they emit β or γ-rays just like radium products, in the process of attaining stability. It is this radioactive property which makes these new elements so valuable in therapy and research. In order to understand how this artificial radioactivity may be produced with the help of the cyclotron, it is necessary to have some idea of the nuclear structure of elements.

THE NATURE OF NUCLEUS

According to modern physics, every atom has a heart (or nucleus) which is surrounded by a cloud of electrons. Inside the heart of the atom are present only two types of fundamental particles—neutrons and protons. A neutron and a proton have nearly the same mass, but the proton has unit positive charge while the neutron is neutral. Every nucleus is therefore positively charged, its net positive charge being determined by the number of protons present. The weight of the nucleus is given by the sum of the weights of neutrons and protons inside the nucleus.

The following figures represent diagrammatically the constitution of seven simplest nuclei. A white dot represents a proton, a black one a neutron. The simplest nucleus is that of hydrogen containing a single proton. Both its mass and charge are unity ($_1H^1$). Next in simplicity is the nucleus of heavy hydrogen (deuteron) containing one neutron and one proton. Its charge is one but mass is two. This nucleus may be represented by the symbol $_1H^2$ where the superscript denotes nuclear mass, subscript the nuclear charge.

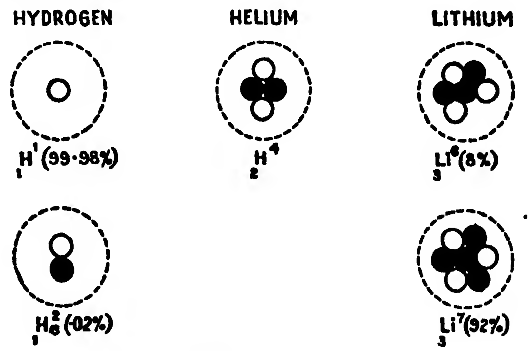

Fig. 1. Nuclei of H, He and Li.

The chemical nature of an element is determined by its nuclear charge *i.e.*, by the number of protons present within the nucleus. As the atom as a whole is neutral, the number of extranuclear electrons is also determined by the charge number or the number of protons within the neucleus. Each succeeding element of the periodic table differs from the one preceding it, by having one more proton within the nucleus and hence one extra electron outside it. Addition or subtraction of neutrons does not alter the nuclear charge. Hence two nuclei with the same number of protons but different number of neutrons will have the same nuclear charge and identical chemical properties. Such nuclei are known as *isotopes*, *e.g.*, hydrogen ($_1H^1$) and heavy hydrogen ($_1H^2$).

The third nucleus in simplicity is that of helium, containing two protons and two neutrons. Then come another pair of isotopes of lithium. $_3Li^6$ contains 3 protons and 3 neutrons while $_3Li^7$ has 3 protons together with 4 neutrons. As we proceed up the periodic table, nuclei become more and more

* Based on a lecture delivered before the Indian Physiological Society.

massive, but they always retain the same elementary composition at heart, *i.e.*, only neutrons and protons. Compare the cases of berellium, boron and carbon.

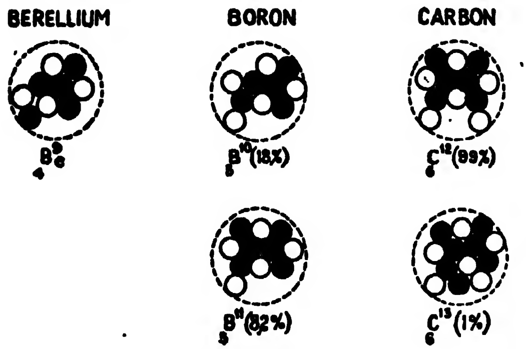

Fig. 2. Nuclei of Be, B and C.

Isotopes occur in nature. Thus normal Li atoms are found to contain 8 p.c. of Li^6 and 92 p.c. of Li^7 nuclei. Similarly natural boron consists of 18 p.c. of B^{10} and 82 p.c. of B^{11}. The percentages of occurrence of natural isotopes are indicated below the figures (1) and (2).

The above picture of the nucleus must be regarded as very elementary. Our knowledge about the nucleus is far from complete. We do not know whether the nuclear particles retain their individuality within the nucleus or if they form a new kind of nuclear substance. But it will be sufficient for the present purpose, if we regard the neutrons and protons inside the nucleus, to be held together by strong forces of the order of million electron volts. If we wish to disrupt the heart of the atom or to bring about changes within it we must hurl at the nuclei projectiles of this energy or more. We must remember that attempts to transform one element into another are being made since the days of early alchemists who tried to change the nature of elements by subjecting them to various chemical reactions. The reason that we have succeeded now where the alchemists failed, is that we now know that so long as the atom remains the same at heart, it will gather round it the same electron cloud and possess the same chemical properties. To transmute one element into another we must produce changes within the nucleus of the atoms. For this purpose such mild persuations as chemical reactions are entirely ineffective. More drastic methods are required ; one of these is to subject the heart of the atom to intense bombardment by other atomic artillery.

Cyclotron and the Generation of High Energy Projectiles for Atomic Bombardment

Many methods have been developed for generating projectiles with large energies for nuclear bursting. Of these, the cyclotron seems at present to be the most efficient. Here nuclei of hydrogen, heavy hydrogen or helium are made to move in a circular path inside two semi-circular electrodes (dees), by the application of a strong magnetic field. The 'dees' are like two halves of a pill box cut along the diameter (fig. 3), the two halves are separated from each other by a gap about 2″ wide.

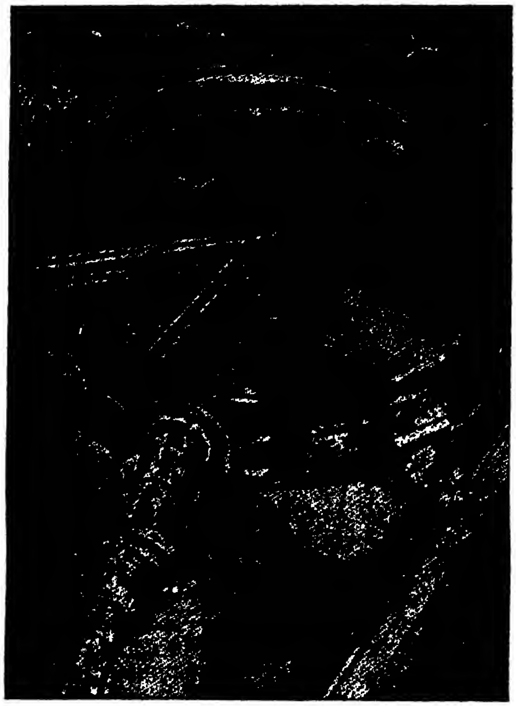

Fig. 3. Cyclotron dees and tank.

A rapidly alternating electric field is applied across the two 'dees', the direction of the field changing from one to the other more than a million times a second. Once the particles are inside the dees they are in a field-free space and are unaffected by any voltage changes occurring on the dees. But when they emerge into the gap between the two halves, they are acted upon by the strong electric field and may be either attracted or repelled. The alternating electric field between the two dees is so arranged that whenever the particle is about to jump across the gap, from one dee to the other the field is so directed that the particle is always given a strong pull towards the next dee. The particles take a very small time (about 10^{-7} secs.) to move across a dee from one gap to the next, the voltage also changes within this short interval, so that the particles are always moving in one direction. Step by step their energies are built up in small increments of 50,000 volts, each time they jump across the gap. As the ions gain in energy

it becomes more and more difficult for the magnet to bend them into circular paths. Hence the particles describe spirals of ever-increasing radius until after 100 or more turns, when the energy is of the order of 5 million electron-volts they arrive at the periphery of the dees. By the application of a suitable deflecting field the beam may be pulled out of the chamber and directed towards any target. (fig. 4)

Fig. 4. Deuteron beam emerging from the cyclotron.

From the very brief description given above let no one think that the construction or the successful operation of a cyclotron is a simple affair. The huge tank housing the cyclotron dees must be completely evacuated of air, otherwise the ions going in their spiral paths will bump so many times with air atoms that they will hopelessly wander away from their fixed course and lose all their energy by striking against either the floor or roof of the dees. Every experienced research worker knows how exceedingly troublesome and difficult it may be to hunt out and rectify minute leaks in a chamber of the size of 3 ft. in diameter! Even when all the leaks have been found and carefully sealed the full power cannot be switched on. The metal parts inside the chamber and the oscillator are very apt to pick up gas, when the cyclotron is not in operation even though the high power pumps are constantly on. During work the metal parts heat up and give up the gases they have accumulated during the period of inaction. A sudden puff of gas given out during the operation may mean the burning out of the filament and suspension of work for a couple of days. This accumulated gas must be driven out first or the apparatus degassed by working it at smaller power. Only when all the undesirable gases have been eliminated carefully, can the desirable ones,—hydrogen or heavy hydrogen, introduced and pressure adjusted to the critical value.

The cycloctron filament and the voltages are turned on for the production of ions to circulate, the main power is then switched on and the ions begin their long journey inside the dees. The oscilator must be carefully tuned, otherwise the ions may be out of step and will not gain much energy. Careful and difficult adjustments in the magnetic field are also necessary in order to keep the ions in focus. Only when all these adjustments have been carried out successfully the beam indicator registers the welcome indication of the ion beam, circulating inside the chamber. Only a fraction of the high energy ion beam circulating inside the chamber, may be brought out of it as shown in fig. 5 by means of a suitable deflecting voltage (about 100 kilovolts).

Production of Radioactive Isotopes of Common Elements

Let us now try to understand what happens when we expose any substance, say, Na to the beam of such high energy deuterons from the cyclotron. Sodium^{23} is a perfectly stable element containing 11 protons, 12 neutrons (written $_{11}Na^{23}$). If such normal sodium atoms are bombarded with a beam of high energy deuterons (nuclei of heavy hyrogen $_1H^2$) some of the deuterons will score direct hits on sodium nuclei. The reaction illustrated in fig. 5 then takes

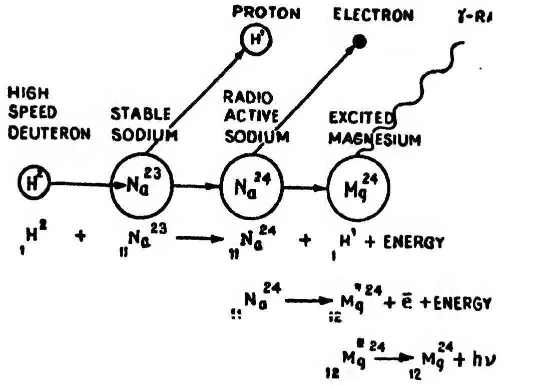

Fig. 5. Production of radio-sodium by deuteron bombardment of normal sodium.

place. The sodium nucleus containing 11 protons and 12 neutrons after capturing the deuteron emits a proton but retains the extra neutron. A new nucleus is formed with 11 protons and 13 neutrons. This is an artificially created isotope of sodium and may be represented as $_{11}Na^{24}$. It has the same chemical properties as normal sodium.

The newly created isotope of sodium containing an extra neutron is however unstable. Left to itself it emits electrons up to a maximum energy of about 1·4 million electron volts and is thereby transformed into excited Mg which again emits γ-rays of three million volts energy. Thus from radioactive sodium one gets β and γ-rays of the same nature as from radium, and Na^{24} can be used in place of Ra. A similar case is that of radioactive phosphorus P^{32}.

When normal phosphorus P^{31} is bombarded with the deuteron beam, a neutron is captured changing normal phosphorus (P^{31}) to the radioactive phosphorus (P^{32}). This emits β-rays of the maximum energy of 1·7 million electron-volts forming stable sulphur (S^{32}). The reaction is illustrated in fig. 6.

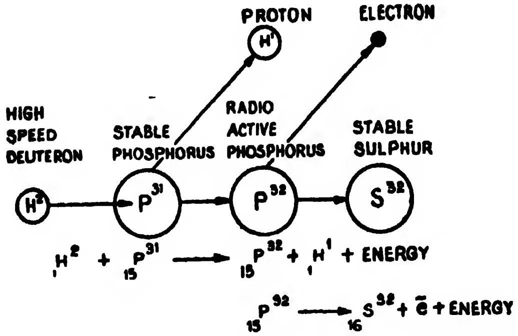

Fig. 6. Production of radio-phosphorus by deuteron bombardment of normal phosphorus.

Radioactive isotopes of almost any element may be produced by bombardment of a suitable stable element either with protons, deuterons or neutrons from the cyclotron. Table I contains a list of those radioactive isotopes which are of biophysical interest. It should be mentioned that the table is not exhaustive. The radioactive isotopes included here are those whose half lives are comparatively long and about whose existence and properties some degree of certainty has been reached. The table gives the atomic number, nuclear mass, nature of radiations emitted, their energy, half lives and the reaction responsible for the production of the isotope. The reactions have been indicated by the usual method, thus the equation Na-d-p against Na^{24} indicates, that Na^{24} is produced by the bombardment of normal sodium by the deuteron beam, when a proton is emitted leaving a residue of Na^{24}. Generally an isotope may be produced by a variety of reactions, of which only one has been indicated.

The yield of artificial radioactive bodies depends on the energy, the number of the projectiles and the nature of the reaction. With the 37-inch cyclotron which is about to be completed the maximum energy of deuterons will be about 8 million electron volts. The 60-inch cyclotron and 200 ton magnet at California produces particles with 16 million electron-volts energy, whose yield of radio-active substance is about 5 times that of the 37-inch one. So great has been the demand for artificial radioactive bodies for medicine and research that a still bigger cyclotron is under construction at California. It will have dees 184 inches in diameter and a magnet weighing 4000 tons. It will produce deuterons of 100 million electron volts energy, its yield of radioactive substances will be 35 times that of the 60-inch one. This cyclotron will cost about a crore of rupees, of which Rs. 45 lakhs have been subscribed by the Rockefellers.

The Technique of Tracer Studies

The radioactive atoms created by man differ from their normal isotopes in having fewer or greater number of neutrons. They contain the same number of protons and the same chemical properties as their normal isotopes. Chemical or biological systems do not in general distinguish between the two. If a very small quantity of radioactive NaCl be mixed with some common salt and the mixture introduced to any human body either by mouth or by injection, wherever the normal sodium ($_{11}Na^{23}$) goes, it carries with it its radioactive partner ($_{11}Na^{24}$). But the radioactive atoms are *marked* or *tagged atoms*. Wherever they go they give evidence of their presence by emitting β and γ-rays of definite energy-values, which are detected by sensitive electroscopes or Geiger-müller counters. By following the fate of such minute doses of applied radioactive substances one can study the problem of metabolism of any normal element. The radioactive elements thus serve as *tracers*, to trace normal elements through complicated biological processes.

This method has several advantages. In the first place when the radioactive element is detected in any organ, one can be sure that it has come from what has been introduced and not from any other body storage depots. When the radioactive element emits γ-rays, the measurements may be carried out *in situ* without sacrificing the animals. This simplifies the technique and saves a great amount of time. The sensitivity of this method of detection is so great that only a very minute quantity of the substance is sufficient.

Let us give an idea of the sensitivity of radioactive method of detection compared to that of the spectroscope. The latter can detect, the presence of 10^{-7} gms. of sodium. But 10^{-7} gms. of sodium, though it sounds a very minute quantity, is large in terms of numbers of atom. It contains about 10^{15} atoms. But even if we have 10^{7} atoms of Na^{24}, about 130 atoms will decay every second, and can be easily detected by the rays they give out. Thus the method is $10^{8} \sim 10^{9}$ times more sensitive. In other words it is 10^{8} to ^{9} times, easier to pick out Na^{24} than to detect ordinary sodium.

Two criticisms have been directed against the use of radioactive tracers in physiological experiments: (*a*) discriminating effect for isotopic elements, (*b*) change in physiological behaviour due to irradiation. The experiments of Barnet, Mullins, Hevesy and others seem to indicate that the radioactive and

TABLE I. RADIOACTIVE ISOTOPES

Radio-element	Radiations emitted		Energy of radiations in million electron-volts		Half-Life	Reaction
	Corpuscular	Electro-magnetic	Particles	γ-rays		
$_{1}$Hydrogen^{3}	electron	...	·015	...	31 years	D-d-p
$_{4}$Berellium^{7}	...	γ-rays	...	·485	43 days	Li-d-n
$_{6}$Carbon^{11}	positron	...	·95	...	20·5 min.	B-d-n
$_{6}$Carbon^{14}	electron	...	·145	...	$>10^{3}$ years	C-d-p
$_{7}$Nitrogen^{13}	positron	γ-rays	·92, 1·20	·28	9·93 min.	C-d-n
$_{8}$Oxygen^{15}	positron	...	1·7	...	2·1 min.	N-d-n
$_{9}$Flourine^{18}	positron	...	·7	...	112 min.	Ne-d-α
$_{11}$Sodium^{22}	positron	γ-rays	·58	1·3	3·0 years	Mg-d-α
$_{11}$Sodium^{24}	electron	γ-rays	1·4	1·4, 2·8, 3·6	14·8 hours	Na-d-p
$_{12}$Magnesium^{27}	electron	γ-rays	1·8	·64, ·84, 1·02	10·2 min.	Mg-d-p
$_{13}$Aluminium^{29}	electron	...	2·5	...	6·7 min.	Mg-α-n
$_{14}$Silicon^{31}	electron	...	1·8	...	170 min.	Si-d-p
$_{15}$Phosphorus^{32}	electron	...	1·69	...	14·3 days	P-d-p
$_{16}$Sulphur^{35}	electron	...	·107, ·120	...	87·1 days	Cl-n-p
$_{17}$Chlorine^{36}	electron	...	0·64($\bar{e}$)	...	$>10^{3}$ years	Cl-n-γ
$_{17}$Chlorine^{38}	electron	γ-rays	1·1, 2·8, 5·0	1·65, 2·15	37 min.	Cl-d-p
$_{19}$Potassium^{42}	electron	...	3·5	...	12·4 hours	K-d-p
$_{20}$Calcium^{45}	electron	γ-rays	0·2, 0·9	0·7	180 days	Ca-n-γ
$_{20}$Calcium^{49}	electron	γ-rays	2·3	·8	2·5 hours	Ca-d-p
$_{24}$Chromium^{51}	electron	γ-rays	...	0·5, 1·0	26·5 days	Ti-α-n
$_{25}$Manganese^{54}	...	γ-rays	...	·85	310 days	Fe-d-α
$_{26}$Iron^{55}	electron	...	...	...	4 years	Fe-d-p
$_{26}$Iron^{59}	electron	γ-rays	·26, ·46	1·1, 1·3	47 days	Fe-d-p
$_{27}$Cobalt^{57}	positron	γ-rays	26 ($\overset{+}{e}$)	·12, ·20	270 days	Fe-d-n
$_{27}$Cobalt^{58}	positron	γ-rays	·4	·6, ·805	72 days	Fe-d-n
$_{28}$Nickel^{57}	positron	...	·67	...	36 hours	Fe-α-n
$_{29}$Copper^{64}	electron	...	0·58 ($\bar{e}$)	...	12·8 hours	Cu-d-p
	positron		0·66 ($\overset{+}{e}$)			
$_{30}$Zinc^{65}	positron	γ-rays	0·4 ($\overset{+}{e}$)	·45, 1·0, 1·14	250 days	Zn-d-p
$_{33}$Arsenic^{74}	electron	γ-rays	1·3 ($\bar{e}$)	·582	16 days	As-n-2n
	positron		0·9 ($\overset{+}{e}$)			
$_{33}$Arsenic^{76}	electron	γ-rays	1·1, 2·7 ($\bar{e}$)	1·5, 2·2, 3·2	26·8 hours	As-d-p
	positron	...	·7, 2·6 ($\overset{+}{e}$)			
$_{35}$Bromine^{80}	positron	γ-rays		·049, ·037, ·025	4·4 hours	Br-n-γ
$_{35}$Bromine^{82}	electron	γ-rays	·46	·55, ·79, 1·4	34 hours	Br-n-γ
$_{37}$Rubidium^{86}	electron	...	1·56	...	19·5 days	Rb-n-γ
$_{38}$Strontium^{89}	electron	...	1·32	...	55 days	Sr-d-p
$_{47}$Silver^{106}	electron	γ-rays	1·2	1·06, ·69	8·2 days	Ag-n-2n
$_{48}$Cadmium^{115}	electron	γ-rays	1·11	·64	2·5 days	Cd-d-p
$_{50}$Tin^{113}	electron	γ-rays	...	·085	70-105 days	In-p-n
$_{51}$Antimony^{122}	electron	γ-rays	·81, 1·65	·96	2·8 days	Sb-d-p
$_{51}$Antimony^{124}	electron	γ-rays	·74, 1·53, 2·45	1·82, 1·75	60 days	Sb-d-p
$_{53}$Iodine^{126}	electron	γ-rays	1·1	·5	13 days	Sb-α-n
$_{53}$Iodine^{131}	electron	γ-rays	·69, ·6	·4	8·0 days	Te-d-n
$_{56}$Barium^{139}	electron	γ-rays	1, 2·3	·6	86 min.	Ba-d-p
$_{79}$Gold^{198}	electron	γ-rays	0·8	·28, ·44, 2·5	2·7 days	Au-n-γ
$_{79}$Gold^{199}	electron	γ-rays	1·01	·45	3·3 days	Hg-n-p
$_{80}$Mercury^{197}	...	γ-rays	...	·20	23 hours	Hg-n-2n
	...	γ-rays	...	·09	64 hours	Au-d-2n
$_{82}$Lead^{209}	electron	...	·70	...	3·0 hours	Pb-d-p
$_{83}$Bismuth^{207}	...	γ-rays	...	·74, ·93	6·4 days	Pb-d-n
$_{85}$Eka-iodine^{211}	α-rays	...	5·94	...	7·5 hours	Bi-α-2n

non-active isotopes have the same physico-chemical properties and as long as the concentration of the radio-element is not so great as to produce changes by the physical effects of radiation, the biological system does not differentiate the stable from the radioactive isotope.*

According to an estimate of Chaikoff, the smallest amount of radioactive phosphorus, the presence of which can be detected with his counter, is about 10^{8} atoms (or $5 \cdot 3 \times 10^{-12}$ mgms.). This corresponds to an emission of about 60 β-rays per sec.

* Slight biological difference (<5·0) has been reported with isotopes of light elements, *e.g.*, D and H, C^{12} and C^{13}. The greatest difference would arise for the isotopes of those elements which function as single ion or atom. The greater the weight of the reacting molecule the less will be the effect due to difference of isotopic masses. In the case of P, for example, it is the mass of the phosphate radicle that is in question, and the difference in weight between $P^{31}O_4''$ and $P^{32}O_4''$ is very insignificant.

or an activity of about $1.5 \times ^{-8}$ millicuries.* The strength of sources usually employed in tracer work is thus much too small to affect the biological processes by causing radiobiologic changes.

In one experiment varying doses of 1—70 microcuries of radioactive prosphorus were injected to five groups of tumor bearing mice. Although the intensity of radiation varied by a factor of 70 no significant differences could be observed in the percentage uptake of radioactive phosphorus by liver and tumor tissues.

How to Introduce Radioactive Bodies

The radioactive substances may be introduced in a variety of ways: (*a*) In the form of an inorganic salt of the isotope used dissolved in water and mixed with other non-radioactive salts; this may be applied either by mouth or injected. (*b*) In the form of organic compounds where the aim is to study the fate of specific organic compounds; the synthesis may be carried out in the laboratory or even within an organism. Thus $Na_2 HPO_4$ containing radioactive phosphorus is fed to rabbits and hens. Labelled phosphatides formed in the liver are absorbed in the plasma. The plasma containing appreciable amounts of phosphatides may be removed, mixed with non-active corpuscles of another rabbit and then re-introduced. The phosphorus content of the different organs of the second rabbit may then be analysed as usual. (*c*) In experiments in plant physiology plant roots may be kept immersed in solution containing radioactive salt.

The accumulation of the elements may be measured by means of counter and electroscopes. Autoradiograph technique has also been employed with great advantage.

The maximum quantity of labelling agent that may be administered is determined by the amount of the element normally present in the system. In the case of I, for example, a normal 200 gm. rat contains only ·05 mgm. of I. The dose of iodine introduced in such a rat must be small compared to even ·05 mgm. On the other hand the normal P content of the body is so high that the introduction of even 6 mgm. of P does not materially affect the normal P metabolism. The great advantage of the method of tracer analysis is that the amount to be introduced need be so small as not to affect the normal balance of even those substances which occur in minutest proportions.

Not all the artificial radio-elements prepared so far can be used in biophysical researches. Artificial radioactive bodies suitable for biological investigations are limited by three factors. Firstly, the radioactive substance should be capable of production in sufficiently large quantities with the help of the cyclotron. This condition is the most stringent of all, as most of the artificial radioactive substances can be prepared now only in small quantities at a large expenditure of energy. Secondly, the radioactive element for biophysical studies should preferably be one that occurs in the biological system by Nature. Its life should neither be too small for easy manipulation (*e.g.* O^{15} half life = 2 min.) nor too long to be taken by man and animals without danger.† On account of these limiting factors the number of radio-elements that have actually been used in biophysical investigations are small. There is no doubt that as the technique improves many more of these artificial radioactive bodies will be put in use in research and in therapy.

In the concluding part of this article is given a very short review of the results of experiments that have been made with the help of artificial radioactive bodies to follow the absorption, storage, utilisation and excretion of various elements by the body in health and disease. The preliminary attempts made to control disease by the action of radiation emitted by these elements have also been reported.

(to be continued)

* Half life of P^{32} is 14·3 days, the probability of disintegration per sec. is $5{\cdot}6 \times 10^{-7}$, the number of atoms disintegrating per sec. out of 10^8 is $10^8 \times 5{\cdot}6 \times 10^{-7} = 56$. This is equivalent to $1{\cdot}5 \times 10^{-9}$ millicuries, 1 millicurie signifies $3{\cdot}7 \times 10^7$ disintegrations per sec.

† Radium has a half life of 1600 years. Owing to its extremely long life radium cannot be taken internally. Smallest amount of injected radium proves fatal because it remains in the system and continues its injurious radiation effects practically without any diminution during our lifetime. A few years ago factory girls engaged in the trade of painting luminous dials swallowed by accident very minute amounts of radioactive material. Each time they touched the brush with their lips to put a point on it, they absorbed a little amount of radioactive material. Although the amount absorbed at any time was almost inappreciable, the cumulative effect was fatal due to the long life of radium. With the artificial radioactive bodies, such as sodium or phosphorus, there is no such danger of cumulative effect as radium poisoning. Most of these decay so quickly that they can produce no lasting injury.

EFFECT OF THE FOOD CRISIS OF 1943 ON THE RURAL POPULATION OF NOAKHALI, BENGAL

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AS a research student of the Department of Anthropology, University of Calcutta, I made a brief survey early in December, 1943 of a few samples of the rural population of the district of Noakhali, affected by the food crisis of 1943. In all I gathered materials from ten villages. The western part of the district was more adversely affected by the food crisis than the eastern one and the Lakshmipur police-station area within the sadar sub-division was the most affected. Unfortunately, I could not collect any data from the Lakshmipur area as necessary facilities for work were not available there.

I did not study the villages as a whole but collected data from some of the families inhabiting these places. For my study I selected three classes of families:—(*i*) those which depended on the gruel kitchen, and so may be considered as most affected by the crisis; (*ii*) those which availed themselves of the dry ration of rice distributed by the Arya Samaj Relief Fund, that is, which were affected enough to accept this charity but had not forsaken their prestige completely to go to the gruel kitchen; and (*iii*) those who neither went to the gruel kitchen nor received any dry ration. This is a fairly random sample of the rural population investigated.

TABLE 1. Showing the particulars of the population studied.

Village	Police-Station	Distance from Chaumohani (in miles)	Family Units	Inhabitants: Hindu	Muslim	Total	P. C. of Total
CLASS I							
Ganipur	Begamganj	1	30	18	109	127	
Chatkhil	Ramgunj	17	55	100	125	225	
Total			85	118	234	352	37
Percentage				34	66	100	
CLASS II							
Changirgaon	Ramgunj	31	30	108	16	124	
Mashimpur	"	33	31	50	80	130	
Kalupur	"	32	8	25	11	36	
Harishchar	"	32	12		74	74	
Arijpur	"	33	10	21	19	40	
Karoa	"	34	10	72	1	73	
Hajipur	"	34	4		19	19	
Total			105	276	220	496	51
Percentage				44	56	100	
CLASS III							
Fakirpur	Ramgunj	32	28		114	114	12
All classes							
Total			218	394	568	962	100
Percentage				41	59	100	

Table I shows the villages, the total number of inhabitants, family units, and the types of family studied. It will be apparent from it that I have studied nearly a thousand people of whom 37 per cent are most affected. 51 per cent affected perhaps in a lesser degree and 12 per cent who had not asked for charity or accepted it. The percentages of Hindu and Muslim populations studied are 41 and 59 respectively. It is true that my data covers a very small portion of the district population and are restricted to only two police-station areas within the one subdivision. But as the villages where I worked had been moderately effected—less than Lakshmipur which represents one extreme and more than the other areas which were less affected, this report, in a general way can be regarded as indicating the average effect of food crisis on the rural population of the district of Noakhali.

I collected my data from the heads of the families in most cases, but where the heads were not available the statements of the reliable neighbours of such families were recorded, and since I was always accompanied by one or two well informed persons of the area who were aware of my mission and always checked up any wrong statement, the data obtained by me can be regarded as correct. I followed the geneological method in my investigation which was followed up by a set of questionnaires prepared beforehand specially for the data regarding the economic life of these people.

Effect of the Food Crisis on the Economic Life of the People

The effect of the food crisis on the economic life of the people is clearly seen, when the loss of property sustained by these people is worked out,

Table 2 (A). Showing the assets of the family units in 1939 and December, 1943; and its loss within the period.

Assets of the family	Property owned				Loss during 1939—43				Detail of loss in 1939—43			
	1939		December 1943		Sample		Percentage		Lost in total		Lost in part	
	Family Units	Valuation in Rs.	Family Units	Valuation in Rs.	Family Units	Valuation	Family Units	Valuation	Family Units	Valuation	Family Units	Valuation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Class I (Family units—85)												
Cultivable land	48	36008	29	16499	27	19504	68	54	14	13844	18	5660
Homestead land	70	35409	67	28759	23	6650	38	19	3	941	20	5709
Dwelling	85	4480	84	3475	25	1005	29	22	1	100	24	905
Ornament	60	2965	10	210	55	2755	92	98	50	2640	5	115
Utensil	45	725	9	155	87	570	82	79	86	555	1	15
Live stock	12	655	5	150	12	505	100	77	7	810	5	195
Total		80287		49248		30989		89		18390		12599
Class II (Family units—105)												
Cultivable land	50	27968	84	12425	80	15543	60	56	16	5610	14	9928
Homestead land	75	81845	72	80524	11	1821	15	4	8	814	8	1007
Dwelling	100	4767	100	4585	9	182	9	4			9	182
Ornament	29	2235	6	295	25	1940	86	87	28	1910	2	30
Utensil	49	686	25	414	26	272	58	40	24	270	2	2
Live stock	19	765	14	1075	8	810	42	41	5	185	3	125
Total		68266		49818		19568		28		8289		11279
Class III (Family units—28)												
Cultivable land	18	18898	17	13881	2	512	7	4	1	896	1	116
Homestead land	26	3498	25	8201	2	297	7	8	1	264	1	88
Dwelling	28	2040	27	1980	1	60	4	8	1	60		
Ornament	6	179	3	65	3	114	11	64	3	114		
Utensil	8	110	7	30	1	80	4	27	1	80		
Live stock	12	1040	7	555	10	485	86	47	5	240	5	245
Total		29760		19262		1498		7		1104		394

since, property is one of the vital indices of economic condition. Table 2 which records the worth of property according to valuation, owned by these people in 1939 and in December, 1943 indicates that from 1939 to 1943, roughly within five years, 39, 28, and 7 per cents of the total property has been lost by the three types of families studied, thus confirming the earlier statement regarding the comparative effect of the crisis on these people. One third or 33 per cent of the families of class I, 32 per cent of those of class II, and 6 per cent of class III have become landless, having lost all their cultivable lands. Further, 4 per cent each of the classes I, II, and III have even lost their homestead land, and two family units belonging to class I and class III have even given up their dwelling!

The table also indicates that of all the assets the ornaments were disposed of earliest, the next in order of disposal being the other belongings like utensils of brass, bell metal, etc. Then came livestock and cultivable land. The homestead land and the dwelling were parted with last of all. It shows that to fight out economic distress the people first gave up the little reserve which they had as ornaments, used normally as luxury articles; next the belongings like utensils which are needed but may be done without undergoing discomfort. Finally, the live-stock, needed for cultivation, and cultivable land, their sources of living, were given up. As some kind of livelihood might be managed by agricultural labour or such, the homestead land and the dwelling (popularly known in Bengal as *Bastu Vita*) were retained. But when there was nothing else to avert distress even the *Bastu Vita* was given up.

The loss of property due to food crisis cannot be judged properly unless we take into account separately of the loss within 1943 or narrowing-down the period still more from March to November 1943, that is, from the time when the crisis was perceptible. This has been done in Table 4 which shows the loss of property during the two periods, (*i*) 1939 to February 1943 and (*ii*) March 1943—November 1943.

One point is to be mentioned before discussing the Table 3. In Table 2 the value of property has been determined according to its valuation in December, 1943 and the loss is calculated on this

TABLE 2 (B). Showing the holdings of cultivable and homestead land of the people in 1939 and December, 1943, and its loss within the period.

Assets of the Family Units	Property owned				Loss during 1939—43				Details of loss in 1939—43			
	1939		December 1943		Sample		Percentage		Lost in total		Lost in part	
	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family Units	Acreage	Family units	Acreage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
CLASS I (Family units—85)												
Cultivable land	48	21·82	29	10·00	27	11·82	68	54	14	8·39	13	3·48
Homestead land	70	21·46	67	17·43	23	4·08	88	19	3	0·57	20	8·46
Total		48·28		27·48		15·85		37		8·96		6·89
CLASS II (Family units—105)												
Cultivable land	50	16·95	34	7·58	30	9·42	60	56	16	3·40	14	6·02
Homestead land	75	19·30	72	18·50	11	0·80	15	4	3	0·19	8	0·61
Total		36·25		26·08		10·22		28		3·59		6·63
CLASS III (Family units—28)												
Cultivable land	18	8·42	17	8·11	2	0·31	7	4	1	0·24	1	0·07
Homestead land	26	2·12	25	1·94	2	0·18	7	8	1	0·16	1	0·02
Total		10·54		10·05		0·49		5		0·40		0·09

basis.* But the real worth of the property lost by sale or mortgage, cannot be decided according to this valuation. For, the standard of valuation, is the current price while the sale price varies from year to year according to the standard of valuation in particular years and was much less previously. The amount of loan contracted by mortgaging the property is also always much less than its valuation. Thus our enquiry revealed that in all 18·89 acres of land have been sold within four years, the valuation of which is about Rs. 24,166/- whereas the actual price fetched during the sale was Rs. 19,865/- that is, difference of about 18 per cent. This difference will be more marked in case of ornaments since the price of gold and silver has increased immensely. In case of the debts secured by mortgages, it is an established fact that the amount of debt is never equal to the actual worth of the security and is usually its half in amount. Hence, strictly speaking, any comparison of the loss of property according to its sale price and the amount of loan from the mortgage, with its valuation definitely leads to an underestimate.

To find out whether the loss of property through sale and unrepaid or unrepayable loans can really account for the total loss, the total amount obtained from the sales and the loans has, at least, to be doubled to allow a fair comparison with the valuation of property. But it must be borne in mind that even then the comparision may not be fully accurate. Table 3 shows that after necessary adjustments, roughly speaking, the total loss of property can be accounted for by sale and mortgage.

Now to come back to our point, the extent of loss of property in different periods to denote the effect of food crisis, has, therefore been recorded in the Tables 4 and 5 as per the sale price of the properties sold as well as the amount of loan contracted on its security, which, however, will not affect our conclusion as the standard is the same for both the periods. Table 4 (A) shows that 56, 49, and 65 per cents of the property with respect to the classes I, II, and III have been lost within March—November 1943, the main period of food crisis, while in the previous period of a little more than four years (1939—February, 1944) the rest 44, 51, and 35 per cents have been lost. Besides this the table shows that out of the total number of family units affected by the loss 93, 91, and 75 per cents have been affected during the period of food crisis while in the period before only 26, 27, and 25 per cents respectively have suffered within the period of a little more than four years compared to the formerly noted 93, 91, and 75 per cents within nine months due to food crisis.†

The effect of food crisis is still more sharply brought out in the Table 4 (B) which shows that during the period of food crisis the property has been lost mainly to acquire food, families of class II having been most hard hit in this respect for the obvious reason that they being a little better off had some assets which they have now disposed of to avert the crisis, while families of class I having already almost used up their reserves had little more to sell. In the previous period the 'other causes' had some share

TABLE 3. Comparing the loss of property in Rupees through sale and unredeemed or unredeemable loans after necessary rough adjustment (*i.e.*, doubling the amount) to the worth of it in 1939, as shown in Table 2(A).

Assets	Worth of Property lost through: Sale (according to sale price)	Mortgage (according to amount of loan)	Total loss (1)+(2)	Total loss of (8) after adjustment	Total loss according to valuation (ref. Table 2)	P. C. of col (4) to col (5)	REMARKS.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cultivable land	15154	550	20415	40830	47060	87	Ornaments were mostly sold in last 10 months and so fetched high price, which accounts for the p.c. surpassing 100.
Homestead land	4711						
Dwelling	1158		1158	1158	1200	97	
Ornaments, Belongings like utensils etc.	2340 359	1335	4034	8068	5670	142	
Live-stock	722		722	722	1240	58	Some cattle were lost through death and so the p.c. is low.
Total	24444	1885	26329	51188		98	

* Thus in December 1943 land was sold at Rs. 1,980 to Rs. 1,320 per acre. Hence the valuation of land is regarded as Rs. 1,650, the average of the two amounts. The valuation of the other forms of property has been estimated in this way. It is noteworthy that in case of dwelling as a form of property what has been lost in most cases is not the entire structure but the iron corrugated sheet used for roofing purposes, the valuation of which has been estimated in terms of current prices. The valuation of the thatched huts has been estimated at Rs. 10/- on the average which is the considered opinion of many reliable persons of the villages.

† It is noteworthy that many families were simultaneously affected in the two periods, so that, the total numbers of affected families in the two periods are not mutually exclusive.

TABLE 4 (A). Showing the amount of property lost and the number of families affected by the loss in different periods. (According to the sale price of the property sold and the amount of loan on its security).

Class	Affected Families			Percentage of		Amount lost in Rs.			Percentage of	
	1939 Feb'43	March-Nov'43	1939-1943.	col (1) to col (3)	col (2) to col (3)	1939-Feb'43	March-Nov'43	1939-1943	col (6) to col (8)	col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	19	67	72	26	93	6232	7925	14157	44	56
II	17	58	64	27	91	5742	5525	11267	51	49
III	4	12	16	25	75	300	565	865	35	65

TABLE 4 (B). Showing the cause of loss of property in different periods.

Class	Loss in Rs. from 1939-Feb '43			Percentage of		Loss in Rs. from March—Nov. '43			Percentage of	
	On food	on other causes	Total	Col (1) to col (3)	Col (2) to col (3)	On food	On other causes	Total	Col (6) to col (8)	Col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	3994	2238	6232	64	36	5812	2113	7925	73	27
II	1262	4480	5742	22	78	5025	540	5565	92	8
III	135	165	300	45	55	565		565	100	

worth mentioning, specially in case of class II. The 'other causes' are the redemption of old debts, expenses for social rites, like marriage and funeral ceremonies, payment of the rent of land to zeminder due from a long ago, and capital expenditure on erecting new dwellings in place of the worn out old structures.

It has already been mentioned that the property shown as 'lost' comes under two heads: (*a*) sold and (*b*) mortgaged to raise loans on its security. Since debts, as declared by the informants, cannot be repaid owing to extreme poverty, the second category of property is also regarded as lost. Table 5 shows the amounts of property lost through sale and such loans. When in dire need the families contracted loans at an exorbitant rate of interest (usually 75 per cent per annum) offering as securities the ornaments and belongings like utensils and rarely the cultivable land. Where land is the security the rate of interest is not so high. Many families took loans mortgaging their lands on terms according to which if the loan be not paid within the settled period of time the land passes on to the money lender.

Table 5 indicates that it is sale which accounts for 92, 93, and 95 per cents of the loss of property. The reason is obvious. Sale fetches a greater amount than mortgaging the property and when there is very little chance of repaying the loans it is best to sell off the property. That sale is of more importance is also proved by the fact that 85, 83, and 88 per cents of the family units have lost their property through sale when the loss through mortgage is only 49, 33 and 13 per cents.

All the tables so far considered prove the fact that the economic condition of these people has deteriorated to an extreme extent and this has mainly taken place in the nine months from March, 1943 to December 1943.

The havoc created by the food crisis in the economic life of the people does not end here. Table 6 which indicates the outstanding debts of these people before and after the main period of the food crisis gives a further glimpse into the picture. Table 6 (A) shows that even before the food crisis the economic life of these people was not a very prosperous one ; 15, 8, and 6 per cents of the family

TABLE 5. Showing the loss of property through sale and unredeemed or unredeemable secured loans (according to sale price and amount of loan), and the number of family units affected by such loss within 1939-1943.

Class	Family units affected by loss					Loss of Property in Rupees				
	Sale	Mort-gage	Total	P. C. of col (1) to col (3)	P. C. of col (2) to col (3)	Sale	Mortagage	Total	P. C. of col (6) to col (8)	P. C. of col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	61	35	72	85	49	13087	1070	14157	92	8
II	53	21	64	83	33	10542	765	11307	93	7
III	14	2	16	88	13	815	50	865	95	5

units being already indebted at the time. But the food crisis accelerated the deterioration tremendously and in December 1943, just after the height of the food crisis the figure rose to 95, 77, and 93 percents, for the three classes. The different groups contracted 93, 55, and 56 per cent of the loans within the period of March—November, 1943. The table also shows what a huge amount of the total loan has been contracted during the period of food crisis alone, it being 88, 42, and 87 per cents of the total for the classes I, II, and III respectively. In class II, it may be noted some families had contracted loans of heavy amounts in the previous period for various purposes mentioned before. Table 6 (B) which records the purposes for which the loans have been contracted indicates that food was the principal purpose of loan even before the food crisis. During the critical months, 97, 95, and 89 per cents are shown to have been contracted to get food in this period as against 3, 5, and 11 per cents in the period before it.

Now if we reconsider the worth of property held by these people in 1939, as shown in Table 2, we find that the total amount of outstanding debt is practically half the worth of the property already lost. Table 7 which gives a detailed analysis of the debt and also compares the amount of debt with the worth of property hold by all the families in 1939 brings it out clearly. In this table in case of the secured loans the total amounts have been doubled for necessary adjustments before comparing them with the valuations of property held in 1939, for reasons stated earlier. This is justified as failure to repay will lead to the loss of these securities.

Before discussing the table it may be mentioned here that regarding the secured loans we have already considered the ornaments, belongings like utensils, and land to some extent as security for the secured loans which remain or will remain unpaid. The securities for the loans noted here, which may be repaid some day are mainly land and dwelling in some

TABLE 6 (A.). Showing the number of indebted families and the outstanding debts in March, 1943 and December, 1943.

Class	Total Family Units	Indebted Families			Percentage of			Amount of debt in Rs.			Percentage of	
		Dec. 1948	March 1948	March-Dec' 43	col (2) to col (1)	col (8) to col (1)	col (4) to col (1)	December 1943	March 1948	March-Dec' 43	col (9) to col (8)	col (10) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
I	85	81	13	79	95	15	93	7160	849	6311	12	88
II	105	81	8	58	77	8	55	10966	6340	4626	.58	42
III	82	26	2	18	98	6	56	1627	210	1417	13	87

TABLE 6 (B). Showing the cause of loan in different periods.

Class	Outstanding debt in March' 48			Percentage of		Debts in March—Dec. 1943			Percentage of	
	On food	On other Causes	Total	col (1) to col (8)	col (2) to col (8)	On food	On other Causes	Total	col (6) to col (8)	col (7) to col (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	644	205	849	76	24	6135	176	6811	97	8
II	3290	8050	6340	52	48	4376	250	4626	95	5
III	150	60	210	71	29	1267	150	1417	89	11

TABLE 7. Showing the different forms of loan and the evaluation of its worth to the total valuation of property in 1939, after necessary adjustment for the secured loans (*i.e.*, doubling the amount).

Class	Amount of Debt in Rs.					Percentage to total loans		Total valuation of property in 1939	Percentage to total valuation as in col 8		
	Unsecured										
	Interest free	with interest	Total	Secured	Total	un-secured	Secured		Un-secured	Secured	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
I	3798	557	4350	2810	7160	61	39	81900	5	7	12
II	3726	1150	4876	6090	10966	44	56	68650	7	18	25
III	1280	270	1500	127	1627	92	8	20760	7	1	8

cases. Where land is the security most of the loans have been contracted under 'usufructuary mortgage' and the rest under 'Rehani'. The usufructuary mortgage works out in the following way. The debtor allows the money lender to enjoy a part or whole of his cultivable holding, the area of which is determined considering the amount of loan, for a fixed number of years in return to the money he gets, and the loan is thus repaid. It is noteworthy that a considerable portion of the unsecured loan classified as without interest was actually taken on agreement that the interest would be paid when repaying it. But the debtors are now totally unable to repay the principal even, and the money lender also, seeing that there is very little chance of getting back even the principal from these totally impoverished persons who have nothing else to lose, would be very glad if the principal alone is repaid. This is why I have recorded such loans as without interest, otherwise it would seem very strange as to how such a large sum could have been obtained interest free. It should be mentioned here that the rate of interest is extremely variable and varies from 12 to even 75 per cent per annum!

Table 7 also shows that except in case of class II most of the loans are unsecured. The families belonging to the class II could procure loans of comparatively bigger sums by keeping their properties as securities which they had and so in their case the secured loan is of greater amount.

It is interesting to note here that with respect to the loss of property, the class I lost in greater percentage than class II, while with respect to the loans contracted the percentages of the total and the secured loans to the worth of property in 1939 are greater in case of the class II than of class I. It shows that the class I has sunk a step deeper than class II. To the former what is now more important is to avert death due to the crisis while the latter, although losing a good deal of property still hope to be able to retrieve them on some future day of prosperity.

The table also indicates the percentages of the secured and total loans to the worth of property owned by these people in 1939. The significance of this will be realised if we try to find out the effect of indebtedness on the economic life of the people. So far it has been clear that in the economic life of these people the process runs like this:—With the gradual economic deterioration the people contract loans, unsecured if possible; when no more loans are available they sell or mortgage properties which they will perhaps never be able to regain and thus they have already lost 39, 28, and 7 per cents of the property, the class I being most affected for the reasons mentioned earlier. Now they will have to do something with the standing debts, especially the secured ones, and this they cannot repay from their regular income at the present time; since their present income is already insufficient enough to compel them to abandon their prestige and ask for charity. Hence the only alternative before them is to give up more property which will be 7, 18, and 1 per cent for the secured loans alone and 12, 25, and 8 per cents for the total debt. It means that these people, who have already lost 39, 28, and 7 per cents of the property now face the prospect of losing about 12, 25, and 8 per cents more! That is, the family units belonging to the classes I and II will lose about 50 per cent of whatever assets they had and then what will be left to them is just the roof to live in and perhaps a little of the land and livestock to remind them of their past source of income. The family units belonging to the class III however have not been so adversely affected.

(To be concluded)

A SOURCE OF NITROGEN FOR SOILS

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LOSS of nitrogen from soil occurs mainly by two agencies, namely, (1) by crops and (2) by drainage. The water that percolates through the soil and goes beyond the root range carries down with it large amount of nitrates. In soils where no crop is growing, this loss is tremendous and may be equal to the total amount of nitrogen removed by crops and drainage. It has been estimated both in India and abroad that the total loss in both ways may total up to 100 lbs. of nitrogen per acre per year.[1]

Crop yields in India are quite low in comparison to those of other countries. Indian cultivators usually do not add manure to their fields and the yields, though at a low level, remain surprisingly constant. Thus depletion of soil nitrogen is going on for centuries without apparent deterioration of the general fertility of the soil. To explain this, theories were necessary to be advanced by several Indian workers[2, 3, 4, 5] where plants like maize, rice etc. were supposed to fix atmospheric nitrogen directly without the help of any associated bacteria. In

some cases, the views appear to be supported by considerable experimental evidence. But plants or crops so studied are very few in number and general possibility of plants fixing their own nitrogen may be ruled out.

Nitrogen content of an average Indian soil may be taken to be in the order of 0·05%. If we consider the soil up to the 3rd feet depth, all nitrogen would have been exhausted in less than 100 years and the soil would have been completely free from nitrogen and hence sterile. As this is not the case, the possibilities of nitrogen addition to the soil may be by (1) rain water, (2) by azotobacter, (3) by blue-green algae and (4) by leguminous crops. It may be assumed that additions of nitrogen by one or other of these agencies account for the constancy of the nitrogen level of the soil despite the huge annual loss of nitrogen.

It has been generally considered possible that the nitrogen status of a soil can be improved by growing leguminous crops. In some cases, if leguminous crops grown are not incorporated to the soil after the grains have been taken out, rather adverse effects are produced. But the acreage under leguminous crops is extremely small as compared to the total cultivated area. An uncertain but moderate estimate of such is about 13% of the total cultivated area. So the rest, that is, about 90%, do not get any benefit from the growth of leguminous crops.[6]

It is known that rain water brings down on an average 4 lbs. of nitrogen in a year per acre.[7] This is only a small contribution, if not at all insignificant, for the total annual removal.

Fixation of enough nitrogen by azotobacter is rather a doubtful process. Ingham[8] has calculated the amount of energy materials that would be required for the fixation of enough nitrogen to account for the total annual loss. This comes to be about 5 tons of sugar or 50 tons of green manure per acre. And this has to be repeated every year for the growth of annual single crops. In practice, hardly anything of the kind is added to the soil.

De[9] obtained evidence that blue-green algae are the main agents of nitrogen fixation in rice soils and the part played by the bacteria is relatively unimportant. Nitrogen fixation by the blue-green algae has also been studied in detail by Singh.[10] Choudhury[11] however, has raised doubts about nitrogen fixation by algae. As we leave these uncertain and conflicting views for arriving at a definite conclusion, we turn our attention to yet another possible source of nitrogen, the atmosphere.

That the atmosphere contains traces of ammonia is already well-known.

Some clays[12] and some very common constituents of soil[13] have got a very high power of absorbing ammonia. Traces of ammonia that occur in the air may be supposed to be absorbed by the soil, retained, nitrified and made available to the growing crop. It is a common experience in the laboratories to see acid bottles covered with white coatings in time. These are due to ammonium salts of the acids which reacted with the traces of ammonia in the atmosphere of the laboratory. The process in the case of soils is, however, not unnoticed in India. Ammonia is known to condense on the surface layers of cultivated soils.[14] Ingham exposed pulverized soil in trays for 18 months and observed a huge increase in total and ammoniacal nitrogen. No loss of organic carbon was noticed and naturally the fixation was not due to bacteria. Slow nitrification was also observed. The increase in 6 months alone, calculated in lbs. of nitrogen per acre, was enough to support a heavy crop like maize.

Though such heavy fixation is hardly possible under field conditions, it is quite plain that the absorption of ammonia from the atmosphere can alone account for the total annual loss of nitrogen from the soil.

As can be expected, absorption of ammonia is very prominent in acid soils. In a fertilizer experiment by Borden[15] with different ammonium salts and ammonia alone in irrigation water it was seen that in a soil of *p*H 5·6 anhydrous ammonia gave the highest yields, while a soil with *p*H 6·5 was indifferent to these different ammoniacal fertilizations.

In a preliminary experiment, it has been found that a soil which has absorbed ammonia retains a certain amount of it tenaciously, and ammonia is not lost even if it is heated to 110 C. A few results are quoted below:

Soil	*p*H before absorption	*p*H after absorption and sun drying	*p*H oven dry	Clay %	NH_3 retained after drying to 100C mgs. per 100 gms. soil.
Dacca	4·97	8·34	6·26	24·8	86
Ranchi ..	5·98	8·66	8·34	24·1	40
Pusa	7·17	7·45	7·59	5·6	18
Sialkot ..	6·86	7·37	7·00	20·1	70
Jorhat ..	5·43	8·38	8·13	10·9	43
Guzranwala ..	7·57	8·05	7·98	18·8	46

Albrecht and McCalla[16] has shown that ammonia retained by the soils easily nitrifies, and nitrates are formed.

Atmosphere is able to supply sufficient ammonia to the plants even in view of the negligible amount of this material in the air. Requirement of carbon for crops is about 100 times more than its requirement for nitrogen. Still it occurs in very small amounts in the air *i.e.* about 100 parts only per

million. Nitrogen or ammonia is much less required than carbon and the ammonia content of the atmosphere may easily satisfy the requirement. And the air near the dwelling places and crowded cities contains more ammonia than the air above the sea water. A few determinations by Angus Smith[17] showed the following amounts of ammonia per 100 gms of air:

City	Ammonia
London ..	.. 0·05
Glassgow ..	.. 0·06
Manchester ..	.. 0·10

Sea water is alkaline and contains some amount of ammonia which is being constantly released by evaporation. It therefore, appears, that the ammonia content of the atmosphere is maintained at a constant level. As there is absorption by the soil there is also replenishment by the sea water.

India spreads over an area of about 520 million acres, and the ammonia of the air over the country, after Newth,[18] comes to be about 100 million tons. It is reasonble to suppose that this amount of ammonia may be constantly feeding Indian soils with nitrogen.

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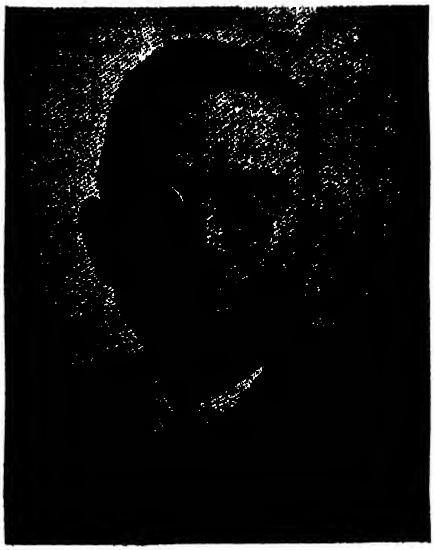
NEW DIRECTOR GENERAL OF OBSERVATORIES

DR S. K. BANERJI, D.Sc., O.B.E., F.N.I.

WE record with great pleasure that Dr S. K. Banerji, D.Sc., O.B.E., F.N.I., has succeeded Dr C. W. B. Normand, C.I.E., as Director General of Observatories on September 10, 1944. Since 1932, Dr Banerji has been the chief administrative officer in the Meteorological Department and was appointed Superintending Meteorologist (administrative) in October, 1938. He officiated as Director General of Observatories on several occasions for a total period of about 2½ years. He is the first Indian to be appointed in this post.



DR S. K. BANERJI

Dr S. K. Banerji was born on the 27th April, 1893, in Malapdia in the district of Dacca. He had a brilliant career in the schools and colleges and finally passed in first class, in 1914, the M.Sc. Examination in Applied Mathematics from the Presidency College, Calcutta. In 1915, he obtained the Premchand Roychand Scholarship, which is regarded as the blue ribbon of the Calcutta University. In the same year, he was appointed an Assistant Professor in the department of Applied Mathematics of the newly founded University College of Science. In 1918, he obtained the degree of Doctor of Science by a thesis on "Some problems in Diffraction and Wave Motion", and in the same year succeeded Dr Ganesh Prasad in the Chair of Sir Rashbehari Ghosh Professor of Applied Mathematics. He thus became full Professor and Head of the Department of Applied Mathematics at the early age of 25.

Soon after passing his M.Sc., Dr Banerji came under the influence of Mr (now Sir) C. V. Raman

and also Professor Ganesh-Prasad. At the suggestion of Professor Raman, Mr Banerji commenced an investigaion of the aerial waves generated by impact and the results were published in a number of papers in the *Philosophical Magazine*, the first of which appeared in 1916. In that connection he developed a new instrument, which he called ballistic phonometer. This early work of Dr Banerji has found place in text books on Sound (Text Book of Sound, by A. T. Jones).

His work on the Theory of Foucault's test and the radiation from the edges of diffractive apertures, published in *Philosophical Magazine*, 1918, is a continuation and development of Lord Rayleigh's work on methods for detecting small optical retardations, and on the theory of Foucault's test (*Philosophical Magazine* 1917), and has been acknowledged as such by Lord Rayleigh (*Vide* Scientific Papers, Vol. V).

At the same time, Dr Banerji became deeply interested in boundary value problems, and in Bessel functions, and published several papers on electrical and acoustical wave motions, surface and tidal waves. He published for the first time, the interesting transformation theorems and several others, which are of considerable value in connection with wave equations.

In 1918, Dr Banerji became the Secretary of the Calcutta Mathematical Society, and also the Physical Science Secretary of the Asiatic Society of Bengal, and remained so until 1922 when he joined the India Meteorological Department. During these years, he attracted round him a number of workers. Under his directions, Mr Bholanath Pal published several papers on Zeros of Bessel functions, which have been reproduced in extenso in Hobson's Spherical Harmonics; and Mr Abani Bhusan Datta many interesting series in Bessel functions, for which he was awarded the degree of Doctor of Philosophy. Dr Banerji published many papers on harmonic functions, and on acoustical and optical problems in the *Bulletin* of the Calcutta Mathematical Society, *Philosophical Magazine, Physical Review, Astrophysical Journal*, etc. His paper in *Physical Review* on vibrations of electric shells partly filled with liquid gives a complete theory of "Musical cups." In the Sir Asutosh Mookerjee Silver Jubilee Volume, 1922, he developed a series of ellipsoidal harmonics and solved the problem of vibrations of a gas in an ellipsoidal envelope, the non-stationary state of heat in an ellipsoid, and several other problems by very simple methods. The ideas contained in this paper have been further developed by F. Moglich in a paper on "Benguugs-erscheinungen an Körporn vol ellipsoidischen Gestalt", (*Ann. d. Phys.*, 83, 1927).

Under his vigorous leadership, the Calcutta Mathematical Society showed a considerable development. Monthly meetings were held in which papers were read and discussed and its bulletins became a quarterly publication.

Dr Banerji took active interest in the Indian Science Congress and contributed papers regularly commencing from its first session in 1914. He was elected President of the Physics and Mathematics Section of the Congress held at Lucknow in January, 1923, and in his presidential address gave a review of the cyclones of the Indian Seas and the theory of their formation, growth and decay.

At the invitation of Sir Gilbert T. Walker, Dr Banerji joined the India Meteorological Service, Class I, in April 1922, and was posted as Director of the Colaba and Alibag Observatories. Here he interested himself in a variety of geophysical problems. His first contribution on the depth of earthquake focus (*Nature*, 1922 and *Phil. Mag.*, 1924) is regarded as a fundamental one and has been widely quoted and referred to in text books on Seismology and Geology. His memoirs of microseisms associated with disturbed weather in the Indian Seas published in the *Philosophical Transactions of the Royal Society*, 1928, opened out a practical method of detecting disturbed weather over the seas, particularly cyclones, and estimating their intensity. He developed the theory of microseisms still further in a paper on "Theory of Microseisms" published in the *Proceedings of the Indian Academy of Sciences*, 1934. He developed a method of recording the electric currents flowing over the surface of the earth ("earth currents") by neutral electrodes, and took continuous records of these currents for a year. The results were published in the *Memoirs* of the India Meteorological Department, Vol. XXVI, 1927, and constitute the only observations available in India of this phenomenon. Dr Banerji set up a series of apparatus for simultaneous recording of electric charges of raindrops, the potential gradient, changes in the gradient produced by lightning flashes, thunder-lightning intervals, and published a number of papers in the *Quarterly Journal of the Royal Meteorological Society* and the *Philosophical Transactions of the Royal Society* on the electricity of overhead thunder-clouds. The distribution of charges in thunder-clouds and other results obtained in these papers have been widely quoted.

Soon Dr Banerji attracted a large number of research students to work with him on various problems, and in recognition of the work done by him the Government of Bombay appointed him as Honorary Professor of Applied Physics in the Royal Institute of Science, Bombay, for a number of years, and conveyed their appreciation of the valuable work done by him. Several students working under him obtained the M.Sc. and PhD. degrees of the Bombay University. Investigations carried on covered a large number of subjects, such as discontinuous fluid

motion, evaporation, artificial vibrations of ground, sound characteristics of Indian alphabets, etc. In a recent communication published in *Indian Journal of Physics*, Dr Banerji has discussed in considerable detail the interchange of electricity between solids, liquids and gases produced by mechanical action, and has shown how these results will affect the "Breaking-Drop" theory of the origin of electricity in thunderstorms.

In 1933, he officiated as the Director General of Observatories for eight months. In 1934 he went to Europe on leave and visited all the important meteorological and geophysical centres. He also attended as a member the International Congress of Applied Mechanics held at Cambridge in 1934 and participated in the discussion.

Before being appointed as the Director General of Observatories, Dr Banerji was Superintending Meteorologist in the Upper Air Office, New Delhi for nearly 2 years. During that period he gave considerable attention to radio-sonde; the chronometric type of radio-sonde, which was in the experimental stage was given the final shape, with several new features, and arrangements were made for its mass production and for daily ascents, which is now a regular feature.

In the post-war, the meteorological service has to play a very important part in relation to civil aviation and agriculture, and it is hoped, that under Dr Banerji's leadership, the department will rise to the height of the occasion.

Notes and News

OUR NEW EDITORS

THE readers of SCIENCE AND CULTURE are aware that the Indian scientists who are now visiting the United Kingdom in response to an invitation extended to them by His Majesty's Government and will shortly be in the United States include three editors of SCIENCE AND CULTURE, namely Prof. M. N. Saha, Prof. S. K. Mitra, and Sir J. C. Ghosh. Dr B. C. Guha, Technical Food Advisor to the Government of India and one of our editors and joint honorary secretaries of the Indian Science News Association, it may be recalled, is now also on tour in Great Britain on a special Government mission. The Indian Science News Association has been particularly fortunate to secure the services of Dr D. M. Bose, Director, Bose Research Institute, and Prof. P. Rây, Khaira Professor of Chemistry, University College of Science, Calcutta, who have kindly consented to serve in the editorial board of SCIENCE AND CULTURE during the absence of these editors. Dr D. M. Bose and Prof. P. Rây will further act jointly as the honorary secretaries to the Indian Science News Association till the return of our permanent secretaries. We extend to them our hearty welcome and assure them our best co-operation and service for the successful prosecution of the activities of the Association.

INDIAN SCIENTISTS IN GREAT BRITAIN

THE proposed visit to the United Kingdom of the Indian scientists at the invitation of His Majesty's Government, first announced in April last and eagerly awaited all these months, has at last taken place. Of the seven scientists constituting the Scientific Mission, Sir S. S. Bhatnagar, Sir J. C. Ghosh, Dr. Nazir Ahmad, Prof. S. K. Mitra and Prof. J. N. Mukherjee left India early in October and are now in Great Britain conferring with eminent British scientists and visiting places of scientific and industrial interest. Prof. M. N. Saha, another member of the Mission, could not accompany the party early in October and later left for England.

The Indian Scientific Mission whose inception may be traced to the influence of Prof. A. V. Hill who recently visited this country has, as its principal object, the establishment of contacts with the scientists of allied nations and to plan arrangements for collaboration and exchange with a view to promoting scientific and industrial status of post-war India. The Mission will also visit the United States of America and, if possible, the Dominion of Canada. The members of the Mission have also expressed their intense desire to visit U. S. S. R., but it is not yet known whether such a visit will be arranged.

The five Indian scientists, immediately after their arrival in London, were accorded a cordial welcome at a historic gathering of scientists at the Royal Society.

At a press conference held in the premises of the Royal Society and presided over by Prof. A. V. Hill, the Indian scientists indicated the need for scientific and industrial development in India. They pointed out that the industries brought into existence as a result of scientific discoveries cannot survive in a competitive world if not continually improved by

fresh ideas and inventions. The war made the authorities in every country conscious of the value of scientific research. Although India has witnessed the creation of a number of scientific organizations, such as Imperial Council of Agricultural Research, the Indian Medical Research Fund Association and the Council of Scientific and Industrial Research, expenditure from public funds on scientific research in India is still insignificant. This war has shown many gaps in India's industrial structure frought with great danger. Considerable development of war and key industries now awaits materialization in the near future, for which capital goods, machine tools and technical knowledge will be needed in increasing amount and variety. The Mission has been authorized to investigate the possibility of obtaining scientific equipment worth several lakhs of rupees from Britain and U.S.A. In this connection the question was asked as to whether part of India's credit balance with Britain which may amount to a thousand million pounds could be spent partly on research equipment. Prof. Hill said, "India will probably need to spend the credit balance in obtaining capital equipment for industries. Without this she could not start on serious industrial development." The scientists expressed firm conviction that modern scientific and technical methods could banish from India disease and low standards of living if freely applied without any interference from powerful vested interests. They also made it clear that the plan for the industrial progress of India can be best carried out under a National Government.

A CENTRAL PLASTIC RESEARCH INSTITUTE

At its meeting held on September 17 and 18 at the Indian Institute of Science, Bangalore, with Sir J. C. Ghosh in the Chair, the Plastic Research Committee of the Council of Scientific and Industrial Research recommended the creation of a Central Plastic Research Institute at a capital cost of Rs. 20 lakhs and recurring annual expenditure of about Rs. 4 lakhs. The Committee fully realized the growing need for plastic research in this country, which covers a vast field of research and development, and strongly expressed its opinion that every attempt should be made to manufacture in India raw materials essential for the development of the plastic industry. Such raw materials are thenol, urea, pythalic anhydride, polyhydric alcohols, acetone, ethyl-, butyl- and amyl-acetate, cellulose-nitrate, cellulose-acetate and cellulose-ethers, etc. The Committee further considered that in the field of natural resins investigation and technical development should be concentrated on shellac, animal and vegetable proteins, resins, vegetable oils, industrial wastes like horn waste, bagasse, coffee-beans, seed cakes etc., and lignin. These investigations and developments call for the establishment of a properly constituted Central Plastic Research Institute of the type recommended. The subject is so vast that original investigators in various parts of India should also be encouraged to carry out laboratory experiments in these subjects, as the Committee has rigtly suggested. Large scale pilot plant experiments on the basis of results so obtained should, however, be carried out in co-operation with experienced workers of the Central Plastic Research Institute.

MORE BARRAGES FOR SIND

We learn with satisfaction that the Sind Government has completed plans to build two more barrages, one in Lower Sind and the other in Upper Sind, and has already placed order for the machinery needed for the job. The Government intends to start operations as soon as possible, and the first excavation work will in all probability be undertaken in November.

The Lower Sind Barrage will be situated at Hajipur, 16 miles below Kotri, and the Upper Sind Barrage at Gudu Head, 90 miles north of Sukkur. Three big canals, all on the left bank of the Indus, will take off from the head of the Lower Sind Barrage, feeding the Fuleli, Piniari and other small canals. Another big canal on the right bank will carry water to the Calavy and Bagha Canal and to the Osto track. Two big canals will take off water from the right side of the Upper Sind Barrage and feed the Begar's Desert Sindwah and other canals.

The project, when completed, will create fresh facilities for irrigation and will be responsible for bringing under cultivation 49 lakhs of acres of additional lands. Rice will be the main crop to be cultivated in the newly irrigated area, but certain dry crops will also be grown.

The two barrages are estimated to cost Rs. 16 crores, according to pre-war estimate. Sind's first barrage at Sukkur, it may be noted, cost 24 crores of rupees, and the money was realized in course of less than ten years in the shape of increased revenue.

LOCUST CONTROL IN INDIA

In the middle of September, representatives of the Teheran International Locust Control Commission, including British, Soviet and Iranian experts, visited this country to confer with the Indian experts on the question of locust control. The conference took place at New Delhi, and the extent of success of the locust campaign in India during the last summer and the possibilities of the degree of invasion which Iran and Arabia might expect from the Indian

side during the next autumn and winter were discussed. It emerged that owing to unusually good monsoons this year locust breeding had taken place over an extensive area of about one lakh square miles in the deserts of Sind-Rajputana. But the control work had been so efficient that an extremely small percentage of hoppers escaped destruction and had given rise to only two or three swarms. This was responsible not only for the saving of India's own kharif crops from locust depredations, but such effective control prevented swarm invasion of the neighbouring countries, *e.g.* Afghanistan, Iran and East Arabia. The foreign experts also visited the breeding areas to ascertain the Indian technique of locust control.

INDUSTRY AND ACADEMIC RESEARCH

According to a report in *Nature*, the Directors of Imperial Chemical Industries, Ltd. have recently made generous provision for eighty fellowships at nine universities in Great Britain. The fellowships are generally meant to be held by senior workers in various branches of science. Although the universities have been given wide choice in the selection of the subjects for research, emphasis has been laid on such subjects in chemistry, physics and allied sciences, namely physical chemistry, biochemistry, colloid science, chemotherapy, pharmacology, engineering and metallurgy, as have direct bearing on the manufacturing interests of the I. C. I. But these subjects, it is to be noted, themselves cover the entire scientific background of modern industry. Only one notices scant attention being given to biological and social sciences in the scheme of fellowship ; but it has also been made clear that the fellowships may be used by the universities to improve the balance of research effort, either in a particular university or between one university and another.

It appears that the main purpose of the fellowship is to strengthen the general provision for scientific teaching and research in British universities. It is realized that future development of industry, particularly the efficiency in industry, depends upon a regular supply of men of requisite ability who can fill high academic and industrial positions. A balanced development of the efficiency in teaching and scientific research in the universities can alone ensure this flow of vital men. In his letter to chancellors of the universities, Lord McGowan most fittingly stated: "Nearly three generations of experience of the administration and conduct of research have convinced us that academic and industrial research are interdependent and complementary, and that it is useless to expect substantial advances in industry without corresponding advances in academic science." Although it is not for the first time that such a remark has been made, Lord McGowan's remark affirming the supreme need for academic research on fundamental problems of science may serve as a warning to those who, in their enthusiasm for industrial research, are prone to underestimate the value of academic research. What is needed is increased co-operation between industry and university, as exemplified in the I.C.I.'s generous provision for fellowships for the promotion of teaching and scientific research in universities. I.C.I.'s instance should inspire similar co-operation in India now that this country is seriously thinking in terms of industrial research and development.

WAR AND OIL

The old slogan that an army cannot march on empty stomach now stands corrected as that an army cannot march on empty oil tank. Speaking of the Allied victory in the last war, Lord Curzon said that the Allies swam to victory on the wave of oil. The part played by oil in the present global war of three dimensions, in which highly mechanized units are carrying on relentless campaigns on land, at sea, and in air need hardly be overestimated. In his article in a recent issue of *Technology Review*, Roland F. Beers quotes some figures relating to military requirements for oils of various descriptions, which make interesting reading. The U. S. armed forces require approximately 50,000,000 gallons (250 gallons = 1 ton) of gasoline, fuel oil, lubricants, and other products of petroleum every day. The U. S. Navy consumed over 1,000,000,000 gallons of oils in 1942 and twice this amount in 1943. Figure for the current year, although not quoted, will doubtless indicate a much greater amount. A mechanized Army division on the move operating with a total horse-power of about 200,000 consumes nearly 18,000 gallons of gasoline per hour.

We have recently heard a good deal about 1000 planes air raids over Germany. A single air raid on such a scale calls for a consumption of more than 1,000,000 gallons of gasoline and 30,000 gallons of lubricating oil. Every Flying Fortress requires not less than 500 gallons of gasoline. It has further been estimated that 3 pounds of gasoline are needed to deliver one pound of bombs filled with petroleum explosives.

The demand for petroleum in the military has become so heavy and exacting of late that even U. S. A., with her vast resources of petroleum, increasingly finds it difficult to cope with it. In 1943, the total consumption of oil in U. S. A. amounted to 1,500,000,000 barrels (46 gallons = 1 barrel). At the beginning of the present year she has been producing at the rate of 4,000,000 barrels a day. Her present production rate is estimated at 4,500,000 barrels a day, which is, however, being maintained with great difficulty. Some operators foresee that in

1945 her daily requirement of petroleum may develop into 5,000,000 barrels a day. For the last few years U. S. A. failed to equalize her output rate with consumption rate and had to draw upon her reserve stocks which are being steadily depleted. In January 1941, U. S. A. had in storage above the ground approximately 263,000,000 barrels of crude oil which declined to 249,000,000 barrels by January 1944. During the same period, her heavy fuel oil stocks dwindled from 86,000,000 barrels to 54,000,000 and gasoline stocks from 90,000,000 to 78,000,000 barrels. Only her stocks of light fuel oil indicated a slight increase from 37,000,000 to 39,000,000 barrels. For this growing deficit U.S.A. has at present to depend on foreign sources of oil and on the possible discovery of new oil fields in her own territory. The article describes how intensively the search for new oils is now going on in U. S. A. for which the services of wildcatters as well as competent scientists, including geologists, physicists, chemists, electrical engineers, mathematicians, bacteriologists, biologists, paleontologists, mineralogists, petrographers etc. have been requisitioned on a large scale. Three hundred and fifty of these crews, numbering up to 15 per crew, are now engaged in their search for oil throughout the United States. The total annual outlay for exploration work is now reported to exceed $350,000,000.

GERMANY'S SYNTHETIC OIL

Unlike the United Nations, Germany is quite adversely situated with regard to her supply of natural oils and has to depend largely on synthetic oils for the successful prosecution of the war. Speculation is rife as to the extent of the output of synthetic oil in Germany, and various figures have been quoted from time to time from more than one source. An article in a leading Swiss paper, according to a report in *The Chemical Age*, recently discussed the synthetic oil situation in Germany and estimated her total output of synthetic oil at 10,000,000 tons per annum.

Oil is produced largely from lignite in which Germany abounds. Most of the larger lignite mining companies have established their own plants for the hydrogenation of coal on the right bank of the Rhine under the leadership of the Gelsenkirchner Mining Company. It is stated that about 30,000,000 tons of lignite mined in the neighbouring Geisel valley are being utilized for the production of synthetic oil. On an average, about five tons of lignite yields one ton of motor fuel. At the Saale Water Works near Leuna, about 800,000 cu.m of water are being daily used for the production of hydrogen required for the hydrogenation of coal. Leuna and the Gleiwitz Works in Upper Silesia are reported to be the most important centres for production of synthetic oil, each having an annual output of over a million tons.

Most of the plants are worked underground for reasons of safety against air raids and are further provided with smoke screen arrangements. The Blechhammer plants are completely underground and are reported to have survived several air attacks. With her growing difficulties of obtaining supplies of natural oil from Rumania, Poland, Hungary and Estonia, Germany will have to depend entirely on her synthetic oils, and her ability to continue the war will be derived from her ability to maintain the tempo of synthetic oil production on an upward curve despite the gloomy prospect of increased Allied air attacks.

INDIAN SUGAR INDUSTRY

The annual general meeting of the Indian Sugar Mills Association and the 13th convention of the Sugar Technologists Association of India, with Mr Lalchand Hirachand in the Chair, took place at Cawnpore on September 11, 1944. In course of his two presidential addresses, Mr Hirachand reviewed the scientific and the economic aspects of the sugar industry and came forward with a number of significant suggestions. He referred to the low average yield of cane in India, which is only 388 maunds per acre compared to 1446 maunds in Java and 1515 maunds in Hawaii. During recent years a progressive decline in yield per acre has been noticed. Furthermore, the Indian cane is deficient in sucrose content as compared to that of Java and Hawaii, which adversely affects the cost of manufacture. It has been estimated that a difference of 0·3 per cent. in the sucrose content affects the cost of production by six annas per maund. With regard to milling extraction and boiling house practices, the Indian industry suffers from low efficiency. Thus, with a fibre content as high as 15 per cent. to 16 per cent., the Indian manufacturers require large quantities of coal and wood to supplement bagasse, whereas the manufacturers in Java, using cane with a fibre content of 11 per cent., do not require any extra coal or wood.

Hardly any use is now made of the important by-products, such as molasses and bagasse, despite immense possibilities of utilizing them as starting raw materials for useful products. Molasses is a potential raw material for the manufacture of power alcohol which, as motor fuel, very nearly approaches the ideal fuel. The use of power alcohol in mixture with petrol up to a percentage of 50 has been made compulsory by legislation in most of the sugar producing countries. Mr Hirachand estimates that about 19 to 25 million gallons of power alcohol worth about Rs. 75 lakhs to Rs. 95 lakhs can be produced in India

from 3 to 4 lakh tons of molasses which is going to waste at present. Despite repeated attempts, the sugar factories in India have been denied the privilege of undertaking the production of power alcohol in India. The Government of India has thought fit to safeguard the vested foreign oil interests in this country and ignore the demand of Indian industries, which may promote economic well-being. "Here lies the difference," remarked Mr Hirachand, "between the National Government and the Foreign Irresponsible Government."

PALÆOBOTANY IN INDIA

PROF. B. SAHNI, F.R.S., acting as Convener and Dr R. V. Sitholey, D.Sc. as Secretary of a committee of 24 botanists working in Paleobotany have now published the 5th annual report of the progress of current research on fossil plants in India (*Proc: Nat: Acad: Sc., 14*, 1-2, 1944). Of the 31 papers abstracted, majority are from Lucknow, by Prof. Sahni himself and by his pupils working under his inspiring guidance. Contributions are also noted from Bangalore, Benares, Bikaner, Hyderabad, Madras and Nagpur. The report includes not only abstracts of papers already published elsewhere but also abstracts of work in progress at the respective centres. An additional feature of these abstracts is that they are fully illustrated.

The outstanding contribution included in this report is an abstract of the presidential address delivered by Prof. Sahni to the National Academy of Sciences at a joint meeting with the Indian Academy of Sciences, in December last year, 'On the age of the Punjab salt in the light of recent evidence'. This long debated question of the age of the saline series has been approached from the micro-paleontological point of view. From the evidences of such microfossils as shreds of Angiosperms, Coniferous wood, wood elements with simple and bordered pits, pollen grains of Angiosperms, cuticles of grasses, fungal hyphae and insect remains *e.g.*, Diptera, it is concluded that the saline series, at least at Khewra in the Salt range, is of Eocene age, as already suggested by Koken and Noetling (1903) and subsequently by Holland, Pascoe, Wadia, Davies and many other geologists. "The saline series of the Punjab salt range, although it underlies the Paleozoic sequence in the eastern part of the range, has come to occupy this inferior position owing to an overthrust of large magnitude which has shoved older beds on the saline series". C. S. Fox and E. R. Gee, however, claim these beds to be as old as Cambrian or Pre-Cambrian.

NOBEL AWARDS FOR 1943 AND 1944

THE report of the Nobel awards in Physiology and Medicine for 1943 and 1944 is just to hand. Professor Kenrik Dam of Copenhagen and Professor Edward Adelbert Doisy of Saint Louis, Missouri, have shared jointly the prize for Physiology and Medicine for 1943. The same award for 1944 has been made jointly to Professor Emeritus Joseph Erlanger of Saint Louis and Professor Herberts Gasser of New York.

Professor Dam discovered vitamin "K" replay and Professor Doisy the chemical nature of the vitamin. Professors Erlanger and Gasser made significant contribution to our knowledge of the manifold and functional differentiations on nerves. It may be noted that the United States alone has annexed three prizes out of four.

SCIENCE IN INDUSTRY

SYNTHESIS OF VITAMIN C FROM BEET PULP

A NEW synthesis of vitamin C based on beet pulp is reported in *The Chemical Age*, July 8, 1944. Developed in America, the method is capable of producing approximately 50 lb. or 23 kg. of vitamin C from one ton of dry beet pulp and bids fair to compare favourably with the process now in commercial use.

The vitamin C, it may be recalled, was first synthesized simultaneously by Reichstein and by Haworth and Hirst. Their method was, however, very laborious and involved the production of galacturonic acid from galactose, its subsequent reduction to *l*-galactonic acid, oxidation to *l*-lyxose and conversion to *l*-lyxosone. Vitamin C was finally obtained by adding hydrogen cyanide and then hydrolyzing the product. In this way many analogues of vitamin C were also prepared. But owing to such tedious operations the method could not be applied successfully on a commercial scale.

The abundance of galacturonic acid, the starting material for the synthesis of vitamin C, in plant materials, such as the dry pulp left after the extraction of sugar from sugar beets and the pulp from

citrus fruits and apples, suggested the possibility of synthesizing vitamin C from beet pulp. The dry pulp contains about 30 per cent of the acid in the form of pectic substances, and a simple method for obtaining salts of galacturonic acid in any desired quantity has now been developed. The method consists in treating the pulp in water with 'Pectinol', an enzyme preparation used for the clarification of fruit juices, when galacturonic acid separates from the pulp and remains in solution with water. The acid, however, cannot be crystallized from the solution as such; the calcium, sodium-calcium and sodium-strontium salts are first prepared by neutralizing the hydrolysate with appropriate bases and their crystals obtained by evaporating the solution. The salts of the galacturonic acid, thus prepared, retain about 18 per cent of the original beet pulp.

The salt of galacturonic acid, say sodium calcium galacturonate, is reduced by hydrogen to sodium and calcium *l*-galactonates with the help of a Raney nickel catalyst. The salt is next converted to *l*-galactonate with sodium chlorate in the presence of vanadium pentoxide. The methyl ester is then treated with sodium methylate to give sodium ascorbate which readily yields crystalline vitamin C.

The new method of analysis is much simpler than other methods now practised. 1 mole of galacturonic acid can theoretically produce 1 mole of vitamin C; or 0·7 part of vitamin C may be derived from 1 part of sodium calcium galacturonate. However, the actual yield has not been found to exceed 20 per cent of the theoretical.

CAROTENE FROM SWEET POTATOES

The United States Government researchers have recently extracted carotene from sweet potatoes, according to a report in *Scientific American*. Sweet potatoes were already recognized as an important potential source of carotine or pro-vitamin A. Acetone was employed for extraction in one of the methods, which gave a product of 90 per cent. purity in a yield of about 39 per cent. The acetone extraction was carried out in four or five stages. The first two stages were concerned with the dehydration of the potato pulp and little carotene was absorbed in these operations. The third and fourth stages in which a greater quantity of acetone was used extracted most of the carotene which was subsequently crystallized.

RUBBER FROM *CRYPTCSTEGIA GRANDIFLORA*

Since the Japanese occupation of Malaya and the Dutch East Indies, the United Nations are deprived of about 90% of their supplies of raw rubber, and the possibility of developing other sources of vegetable rubber are being explored.

Mr A. L. Griffith, Silviculturist, Forest Research Institute, Dehra Dun, in the Indian Forest leaflet No. 64 (Silviculture), 1944, describes the practical experience gained during the past year in the raising of *Cryptostegia grandiflora* (Asclepiadaceae), as a war time emergency plantation crop, which calls for maximum production in the minimum time, with cost as a secondary consideration. The information is intended to help those engaged in raising plantations this year so that the best use is made of the experience gained so far.

The plant is indigenous to Madagascar and probably to Africa and many years ago was imported into India as a garden plant for its flowers. It is now found growing in all parts of India in various types of soil, in all climates without regard to temperature, rainfall, humidity, in deserts and in dry areas, in river banks and in places where the sub-soil water table is high. Thus the plant displays an amazing adaptability to wide variations in environment. "A well-drained fertile soil with a gentle slope at about 100 ft. elevation and a rainfall of about 60 inches will suit it best, particularly if facilities exist for irrigation in periods of dry weather."

Care must be taken not to collect the seed until it is fully ripe and also that the seeds are correctly identified, as the pods of *Cryptostegia buchanani* are likely to be mistaken for those of *Cryptostegia grandiflora*. The most successful method is to soak the seed in cold water for 24 hours before sowing. Germination starts in 10 days and is complete in about 24 days.

The leaflet gives full details of nursery practice, plantation technique, rate of growth and other details of cultivation.

The cost of a plantation unit of 5000 acres would be about Rs. 200 per acre and of this about Rs. 100 per acre represent expenditure on equipment etc. The number of plants varies from 7,000 to 19,000 per acre but there is no data of the production of rubber per acre and the per cent of the rubber content of the dry weight of *Cryptostegia*.

Today when this vital war material is discussed interest centres on synthetic substitutes or to other vegetable sources. In America, *Perthenium argentatum* (Guayule plant), a desert weed which grows wild in Mexico, is now being intensively cultivated in U.S.A. under Government direction. The story of its growth and development, particularly as seen in the Salinas valley of California, is given in the *Geographical Magazine*, XVI, September, 1943.

PROTECTION OF TIMBER FROM BEETLES

Mr J. C. M. Gardner, Forest Entomologist of the Forest Research Institute, Dehra Dun, in another leaflet No. 69 (Entomology), describes preliminary

tests of two methods of temporarily protecting timber from certain borers *e.g.*, Powder-post beetles of the family Bostrychidae.

A mixture of creosote and fuel oil in equal proportions or of 1 creosote to 4 fuel oil applied externally definitely prevents attack for at least 9 months or longer. Tests were made using sapwood of highly susceptible *Dalbergia Sissoo*, kept under shelter.

A coating of lime wash gave complete protection for 3 months using two highly susceptible species *e.g.*, *Mangifera indica*, and *Albizzia procera*. The treatment must be applied within a short period of cutting or sawing and new cuts must be treated at once. Lime wash formula is 5 lbs of lime, 4 chattacks of gum, and 8 seers of water, which is enough to give three coats to 100 sq. ft. *Boswellia serrata* when treated with only ordinary lime in water is immune from both fungus and insects.

Timber of most broad-leaved trees are liable to severe damage by beetles while the wood of Coniferous trees is immune from these borers. The damage is caused by larvae which feed only on sapwood, and losses due to these beetles are very great indeed.

RETTING BY HIPAROL AND ITS COMMERCIAL APPLICATION

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THE process of retting of fibrous plants is well-known. The method practised by the growers is usually one of stacking jute, coconut and other fibrous plant parts in water and letting bacteria decompose the plants and cause separation of the fibre-bundles from cortex and wood. This method has obviously its disadvantages because (1) the time required for retting is unusually long and it varies from 6-10 weeks or more, (2) fibres of low quality due to over-retting or under-retting are usually obtained owing to lack of standard methods determining completion of retting, (3) water is polluted and forms a favourable place for the breeding of mosquitoes. The problems connected with this process have been investigated by various workers using anaerobic and aerobic methods of retting by bacteria (Ruschmann, 1924 ; Thaysen and Bunker, 1924) or by chemical methods (Chatterjee, Nodder, Sarker, 1944) to improve the quality of the fibre and reduce the time required for retting, but so far, the limits of none of these methods have been fully investigated. Patel and Ghosh (1943) have described in jute the changes due to disintegration of tissues caused by micro-organisms but the rôle micro-organisms play during retting have not been studied. The break-down of plant tissues by bacteria is generally believed to be due to the action of enzymes secreted by the parasites during their growth ; pectins in the middle lamella of the softer parenchyma which holds the fibre-bundles together are found to be broken down during retting by the enzymic secretions of bacteria known as pectinases. The delay caused in retting may be due to the slow production of pectinases by bacteria attacking the plants or of insufficient amounts of enzymes produced, because production of pectinases by bacteria is not only influenced by the rate of growth of bacteria on the plant-tissues but also by the chemical nature of the substrate influencing the formation of enzymes capable of breaking down plant-tissues. It is, however, possible to produce enzymes capable of breaking down plant-tissues actively *in vitro* from fungi or bacteria parasitic on plants and determine the rate of hydrolysis. Since retting involves mainly break-down of pectic materials by enzymes elaborated by bacteria, it is possible that active enzymes produced *in vitro* from fungi may hydrolyze pectins and cause retting of fibrous material. The break-down of plant-tissues is, however, due to a mixture of enzymes and not to one enzyme alone (Baruah, 1942). Hiparol previously reported by us (1944) as being capable of retting fibrous material is a mixture of enzymes and has been extracted from a mould, on a large-scale by methods as followed by Baruah (1942). Investigations described below concern determination of the activity of Hiparol, its use as a retting reagent and its application in commerce.

The terms used to denote the enzymes in Hiparol causing changes in the plant-tissues are as follows. The term lamellase is used to denote maceration of tissues, the macerating enzyme being previously called by various workers, 'cytase', 'pectinase' and 'protopectinase'. The changes in pectin, which, according to Myers and Baker (1934), is a complex of eight molecules of galacturonic acid, seven of the carboxyl groups being methylated with one molecule each of arabinose and galactose and two of acetic acid, are caused by several enzymes, and the term pectinase is used, therefore, in the broad sense, to cover the enzyme complex which breaks down the basic structure of the pectin molecule. The most important enzymes are pectin poly-galacturonase

acting upon the poly-galacturonic acid in the molecule and pectin-methoxylase causing splitting off of the CH_3O groups attached to most COOH groupings of pectins. Protopectinase is used here to denote the activity by which soluble pectin is formed from insoluble protopectin.

Activity of Hiparol

The criteria used for determining the activity of Hiparol were as follows :—(1) rate of maceration of blocks of plant-tissues ; (2) the changes in the physical and chemical properties of pectin solutions ; (3) rate of break-down of fibrous plant-tissues ; methods used for determining the activities were those as followed by Baruah (1942).

Hiparol used was the substrate on which the fungus was grown and enzymes were extracted in water. For the preparation of 2% Hiparol mixture, 2 gms. of the substrate on which the fungus was grown were treated with 100 c.c. of water, and the enzyme extract was used.

Blocks of plant-tissues of 2 cms. × 1·0 cms. × 0·5 cms. size were immersed in 2% Hiparol mixture at *p*H 5·0 and the time required for loss of coherence of plant-tissues was noted. Controls were set by immersing plant-tissues in 2% boiled Hiparol mixture at *p*H 5·0, enzymes being deactivated by heat. Table 1 shows the time required for maceration of blocks of plant-tissues.

TABLE 1

Time of Maceration of Blocks of Plant-tissues

Type of plant-tissue	Time required for maceration of blocks of plant-tissues	Control after boiling
Mango	20 minutes	No action
Apple	20 ,,	,,
Pineapple	20 ,,	,,
Grapes	20 ,,	,,
Orange rind	25 ,,	,,
Lemon rind	40 ,,	,,
Tomato	25 ,,	,,
Banana	25 ,,	,,
Guava	35 ,,	,,
Pumpkin	42 ,,	,,
Tender coconut husks ..	40 ,,	,,
Mature coconut husks ..	42 ,,	,,
Mature jute stem	8-10 hours.	,,

The following facts are evident from Table 1 :—

(1) Hiparol macerated mango, apple, pineapple, grapes-tissues in 20 minutes.

(2) Orange rind, banana tissues were macerated in 25 minutes whereas guava, lemon rind and pumpkin-tissues were macerated in 35-42 minutes.

(3) Coconut husks were macerated in 40-42 minutes, fibres being completely loosened from the matrix. Fibres from the outer skin were also separated by the enzyme action.

(4) Jute stem was macerated in 8-10 hours, fibres being completely loosened from the cortex and wood. Slimy material was usually observed on the surface of the skin.

(5) There was no action in the controls, heat deactivating the enzymes.

Hiparol macerates plant-tissues by decomposing the middle-lamella, lamellase being the enzyme responsible for its break-down. (Baruah, 1942). The break-down products of the middle-lamella by lamellase are not yet known. Evidence obtained by studying histological changes in coconut, jute, mango, orange-rind tissues caused by Hiparol shows that loss of coherence of plant-tissues is due to extraction of pectins from the cell-wall and its break-down by the enzymes as well as to the decomposition of the middle-lamella (details to be published in a subsequent paper).

Pectinase breaks down pectin by a sequence of changes, both physical and chemical, affecting the basic structure of the pectic molecule ; changes in pectin caused by Hiparol are shown in Table 2 and Fig. I and may be described as follows (for experimental purposes, 100 c.c. of 1 per cent pectin and 10 c.c. of 5 per cent Hiparol were used and the changes were noted simultaneously) :—

TABLE 2

Changes in Pectin caused by Hiparol

Time in hours	Relative viscosity %	Amount of Un-decomposed pectin	Amount of reducing sugar as dextrose Iodine-reduction	Saponification value as gms. of NaOH per 100 gms. of dry ash-free pectin.
0	100	1·0 gm.	2·5%	9·6 gms.
3	41·3	0·56 ,,	4·9%	8·9 ,,
24	7·8	0·42 ,,	6·2%	6·46 ,,
48	3·9	0·36 ,,	31·5%	5·0 ,,
72	3·4	0·30 ,,	31·5%	3·52 ,,
96	2·6	0·21 ,,	31·5%	2·79 ,,
120	1·5	0·14 ,,	32·0%	2·50 ,,

(1) There was a gradual decomposition of pectin and a rapid decrease in viscosity of pectin solution, relative viscosity of pectin solution being reduced to 7·8 per cent after 24 hours.

(2) The increase in the amount of reducing sugar was rapid within the first 48 hours, after which the rate of production was almost constant.

(3) There was a gradual decrease in the saponification-value of pectins showing the changes in the degree of demethylation during hydrolysis.

It thus appears that the break-down of pectin by Hiparol is accompanied by a decrease in viscosity and in the saponification-value and by a corresponding increase in the reducing power of pectin. The rapid decrease in viscosity may be due to the splitting off

of secondary aggregates of polygalacturonic acid chains in the molecule and may be likened to the liquefaction of starch by enzymes or by acid-hydrolysis (Kertesz, 1939; Hirst and Young, 1939). The chain structure of the pectic molecule and its first break-down products which contain galactose, arabinose and galacturonic acid residues is further broken down and the reduction of pectin and the change in viscosity increased to the maximum (Fig. I). The sequence of changes in pectin caused by Hiparol is similar to that obtained by *P. digitatum* extract and *B. cinerea* extract (Baruah, 1942).

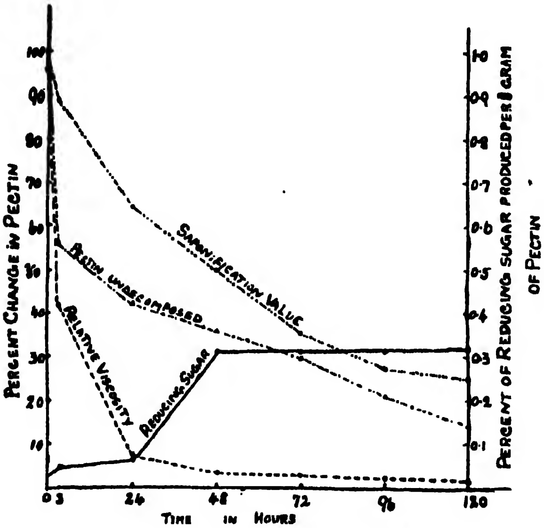

FIG. 1. Extent of changes in Pectin caused by Hiparol (Temp. 25°C.)

The effect of Hiparol on fruit juices was also investigated and it had been found that viscosity of tomato juice, orange juice, apple juice, mango juice, pineapple juice decreases rapidly, the break-down of pectin soluble in juice being accommpanied by a rapid decrease in viscosity (Table 3).

TABLE 3

EXTENT OF CHANGES IN VISCOSITY OF FRUIT JUICE BY HIPAROL

Fruit juice	Initial viscosity %	Relative viscosity % after 30 minutes
Orange juice	100	2·8 %
Tomato ,, ...	100	5·5 ,,
Mango ,, ...	100	20·9 ,,
Pineapple ,, ...	100	15·8 ,,
Apple ,, ...	100	31 ,,
Grape ,, ...	100	75·7 ,,

The maximum change in viscosity was with orange juice and tomato juice, viscosities being reduced to 2·8 per cent and 5·5 per cent respectively. This property of rapid decrease in viscosity of fruit juices when acted upon by Hiparol, can be made use of in the clarification of fruit juices and the extent of hydrolysis used as a measure of the enzyme action.

Protopectinase, an enzyme that forms soluble pectin from insoluble protopectin, is also present in Hiparol, since the insoluble protopectin present in plant-tissues is rendered soluble and is in turn broken down by pectinase (pectin-polygalacturonase). 1 gm. of lemon protopectin on being treated by 5 per cent Hiparol was broken down, and the amount of protopectin decomposed and the amount of reducing sugar formed during hydrolysis were 0·54 gms. and 0·30 gms. dextrose respectively, soluble pectin formed being decomposed by the enzyme extract to reducing sugar.

Experiments with hemicellulose and cellulose fractions of plant-tissues show that Hiparol has no action on either of the substrates, substrates used being hemicellulose obtained pure from lemon cell-wall material and cellulose being cotton wool, filter paper and tailor's cuttings.

It thus appears that Hiparol attacks chiefly the pectic constituents of the cell wall thereby causing maceration and break-down of the tissues and has no action either on hemicellulose or on cellulose.

USE OF HIPAROL IN RETTING

The fact that break-down of blocks of jute, coconut is due to the removal of pectins from the tissues and the decomposition of the middle-lamella by actively potent pectin-splitting enzymes present in Hiparol has been made use of in the retting of jute, coconut and other fibrous plants on a large scale.

For experimental purposes, 50 gms. of Hiparol powder were suspended in a litre of water and stems 7″ in length of jute, coconut husk and Calotropis Sp. were immersed in the mixture at *p*H 5·0; the time required for retting, that is, the time required for maximum ease of separation of the fibres from the cortex and wood was noted, fibres being obtained by washing and stripping (Table 4).

TABLE 4

TIME REQUIRED FOR RETTING BY HIPAROL

Type of plant tissue	Immature	Mature	Dry
Jute	30-48 hrs.	18-24 hrs.	12-16 hrs.
Coconut husk	20 ,,	16 ,,	10-12 ,,
Calotropis*	52 ,,	30 ,,	24-30 ,,

* Calotropis stems were kindly supplied by Dr B. C. Kundu.

The time required for retting varies from 12 to 48 hours for jute, from 10 to 20 hours for coconut, and from 24 to 52 hours for Calotropis. Coconut husk is easily retted since the fibrous mesocarp of the

coconut husk, due to its spongy nature, is readily exposed to the enzymes, but in jute and other fibrous plants having a complete covering of highly cuticularized epidermal tissues, cells of the inner parenchymatous tissues are not freely exposed to the enzyme action. In the normal process of retting by stacking in water, bacteria invade the plant-tissues gaining entrance through wounds, stomata or cut surfaces and multiply inside the plant-tissues causing breakdown of the tissues. In the enzymic process by Hiparol, pectins in the plant-tissues are broken down, resulting in loss of coherence of the tissues. Diffusion of enzymes into tissues taking place through wounds, stomata or cut surfaces of plants causes softening and disintegration of the tissues; continued immersion, however, for one to two days reduces the epidermal resistance, causes swelling of the tissues and makes absorption of enzymes possible on a large scale by the plant tissues, slimy gums being noticed on the stem and young leaves adhering to the stem disorganized.

The time required for retting varies in different regions of the stem. For instance, apical region in jute stem is more susceptible to enzyme action than middle and basal regions of the stem; the time required for retting by the former varies from 12 to 16 hours whereas the middle and basal regions require 24 and 40 hours respectively. The entire breakdown of the apical region and parts of the middle region of the stem in jute by Hiparol shows that the epidermal layer, although resistant to enzyme action, can be broken down by enzymes during hydrolysis, breakdown being probably caused by swelling of the tissues. Patel and Ghosh (1943) also observed difference in the time of retting for different regions of the stem and found that the time varies from 5 to 20 days. This difference in time required for retting may be due to the difference in the degree of hydrolysis of the pectic cell-walls in different regions of the stem, influencing the ease of penetration of enzymes into the plant tissues. Ease of retting appears, therefore, to be influenced by (1) the degree of hydrolysis of the epidermis, and (2) the rate of diffusion of enzymes into plant-tissues. Given, therefore, an exposed surface of pectic cell walls, the action of Hiparol as a retting reagent is most pronounced, as in coconut.

Some of the experiments on a larger scale using different plant tissues are as follows—

(1) 2000 gms. of mature coconut husks were immersed in 20 litres of water containing 200 gms. Hiparol powder at *p*H 5·0; the time required for retting was found to vary from 16 to 20 hours.

After the retted husks had been removed, another lot of 1000 gms. of husk was immersed in the same mixture; time required for retting was found to vary from 20 to 26 hours. A further addition of 100 gms. of Hiparol powder to the same mixture reduces the time required for retting to about 16 hours. Minute fibres of the outer skin were also extracted easily from the husk. The use of Hiparol in subsequent series of retting after the first retting had been done, may be of economic benefit to the growers, and in case of decrease in activity, the activity can be restored by smaller additions of Hiparol to the original mixture.

(2) Jute plants, both immature and mature, were immersed in troughs of galvanized lead sheets of $9' \times 6'' \times 4''$ size, containing 400 gms. of Hiparol in 15 litres of water; the time required for retting was found to vary from 2-4 days. The increase in time is probably due to low concentration of Hiparol used, it being only slightly above 2·5 per cent, and also due to nonuniform wetting of the whole plant. Experiments carried out in tanks at higher concentrations of Hiparol may reduce the time required for retting.

The time required for retting of different types of fibrous plants varies with the type of plant, degree of hydrolysis of pectic cell-walls and mechanical hardness of the plant-tissues (Table 5)

It will be seen from Table 5 that the bark of Girardinia heterophylla, commonly growing in Sikkim, yields a fine silk fibre of high tensile strength in 24 hours whereas Calotropis and Pandanus require 2-4 days for retting. The waxy nature of the skin in Calotropis and Pandanus makes retting difficult. Barks of Bauhinia, Maoutia and Plantain sheath were retted in one or two days. Bark of Girardinia, although very hard and tough, was retted more easily than Pandanus, Calotropis and Agave, resistance to enzyme action in the latter being confined to the waxy cuticularized epidermal layer.

TABLE 5

TIME REQUIRED FOR RETTING OF DIFFERENT KINDS OF PLANTS

Type of plant tissue	Time required for retting	Quality of fibre
*Girardinia heterophylla bark	24 hours	Fine silk fibre
*Bauhinia purpurea bark	24-48 ,,	Coarse silk fibre
*Maoutia puya bark ..	2-3 days	Coarse fibre
Calotropis	3-4 ,,	Cotton-like silk fibre
Pandanus	3-4 ,,	Coarse fibre
Plantain sheath ..	1-2 ,,	Fine silk fibre
Agave	2-4 ,,	Coarse fibre
Hibiscus	2-3 ,,	Fine fibre
Linum	2-3 ,,	Coarse fibre
Pineapple leaf	2-3 ,,	Coarse fibre

* These were identified by Mr S. N. Bal of the Indian Botanical Survey.

The extent of break-down of jute, coconut, Girardinia and Bauhinia during hydrolysis by Hiparol has been followed by determining the amount

of cell-wall material, prepared from the above mentioned plants by drying, decomposed and the amount of reducing sugars formed. Table 6 shows the amount of undecomposed material and the amount of sugar formed during hydrolysis, after 24 hours (for experimental purposes 1 gm. of cell wall material was treated with 5 per cent Hiparol and the mixture was incubated for 24 hours; method of determination was the same as that used by Baruah, 1942).

TABLE 6

AMOUNT OF CELL-WALL MATERIAL UNDECOMPOSED AND OF REDUCING SUGAR FORMED DURING HYDROLYSIS

Type of cell-wall material	Amount of cell-wall material undecomposed	Amount of reducing sugar as dextrose
Jute	0·50 gms.	0·32 gms.
Coconut	0·82 ,,	0·16 ,,
Girardinia ..	0·70 ,,	0·18 ,,
Bauhinia	0·66 ,,	0·20 ,,

The extent of breakdown varies with the type of plant used, maximum break-down being with jute and least with coconut. Reducing sugar is formed by the decomposition of the cell-wall material by the enzyme extract, the amount formed being equivalent to that formed when pectin is hydrolyzed by the enzyme extract.

Hiparol is thus capable of retting not only jute but many other fibrous plants, the rates of activity being influenced by the degree of hydrolysis of the pectic cell-walls, uniformity of wetting, diffusion of enzymes and the concentration of the enzyme extract.

QUALITY OF FIBRE AND THE COST OF PRODUCTION OF HIPAROL

Fibres obtained are of uniform quality and retain lustre and high tensile strength and are free from specks of adhering bark. Hiparol appears to be reasonably cheap and is easy to handle (details to be published later).

CONCLUSIONS

The main conclusions reached, concerning the retting of jute and other fibrous plants by Hiparol and its use in commerce, are as follows.

(1) The break-down of plant-tissues is caused by the decomposition of the middle-lamella, by lamellase and the removal of pectin from the cell wall by pectinase complex by a sequence of physical and chemical changes in the pectin molecule.

(2) Retting of jute, coconut and other fibrous plants is more rapid by Hiparol, a mixture of lamellase, pectinase (pectin- polygalacturonase and pectin methoxylase) and protopectinase than by the normal process of stacking in water hitherto used. The extent of breakdown of cell-wall material of jute, coconut, Girardinia and Bauhinia by Hiparol may be used as a measure of hydrolysis of fibrous material during retting, and it is likely that it may parallel the extent of breakdown of jute and coconut by bacteria during retting.

(3) The case of breakdown of plant-tissues is influenced by the degree of hydrolysis of pectic cell-walls, rate of diffusion of enzymes and concentration of the enzymes extract.

There appears to be an immense possibility of Hiparol being used in commerce since the use of this substance may make it possible to ret the fibrous plants in a much quicker time without impairing the quality of the fibre and to clarify fruit juices. The preparation of ropes, mats, coirs and boards from coconut husks may be more readily obtained by using Hiparol than by the methods hitherto used. Extraction of fibres of fine quality and high tensile strength is also possible from many of the fibrous plants. For example, bark of Girardinia and Maoutia yields fine fibres in 24 to 48 hours on being retted by Hiparol.

Some of the results obtained on the nature of break-down products formed during hydrolysis by Hiparol on substances of various compositions and also on fibrous material during retting indicate the complex nature of Hiparol which contains, besides pectin-splitting enzymes, others of the nature of carbohydrases and also anti-bacterial toxins, and they will be published in a subsequent paper.*

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MEDICINE AND PUBLIC HEALTH

THE AMERICAN MEDICAL ASSOCIATION

THE Association's headquarters at Chicago is an impressive building of eight stories. The membership of the Association on the 1st September, 1942 was 122,033 members. It is connected with 2053 Component County and District Societies and 54 Constituent Associations in States and Possessions. The affairs of the Association are managed by the House of Delegates, under whom is a Judicial Council, a Council of Scientific Assembly and a Council on Medical Education and Hospitals, which determines its policies. There is a Board of Trustees which functions as the governing body in the interval between meetings of the House of Delegates and is charged with the duty of administering the affairs of the Association. The Board of Trustees controls the Journal of the American Medical Association, special journals, Hygeia, Library Committee of Scientific Exhibit, Council on Pharmacy and Chemistry, Chemical Laboratory, Bureau of Investigation, Bureau of Health Education, Bureau of Legal Medicine and Legislation, Council on Physical Therapy, Council on Foods and Nutrition, Bureau of Medical Economics, and Council on Industrial Health.

The Annual Sessions of the Association are held in various sections of the United States and are more largely attended than any other medical meeting. The Scientific programmes are presented through the 17 Sections of the Scientific Assembly and the General Scientific Meetings. The Scientific Exhibit is an important and distinctive feature each year, averaging over 200 individual and special exhibits dealing with advances in scientific medicine. The Technical Exhibit is always comprehensive and complete. Many enjoyable social functions are provided for Fellows and their wives.

The Judicial Council deals with all questions of ethics and rights, privileges and obligations of members or fellows. It also advises on controversies between members of different constituent associations.

The Council on Medical Education and Hospitals has helped in improving the standards of medical education to a high level. It also helps in collecting and disseminating information about hospitals.

The Council on Scientific Assembly is charged with the responsibility and duty of arranging the programmes of general meetings of the Scientific Assembly, and considers questions of policy in relation to scientific work.

The Biographical Department maintains a biographical card index of qualified medical graduates and licensed physicians of the United States and Canada.

The Council on Pharmacy and Chemistry aims at protecting the medical profession and the public against fraud, undesirable secrecy and objectionable advertising in connection with proprietary medicinal articles, and thus acts as a leading advisory body in the field of rational therapeutics.

The Council on Physical Therapy assists in gathering and disseminating such information as will assist the medical profession in determining the therapeutic and diagnostic value of certain devices and methods employed in the practice of medicine.

The Council on Food and Nutrition is concerned with evaluating nutritional claims for food products.

The Council on Industrial Health looks after the improvement of standards in the field of industrial practice. It tries to inform the profession of developments in the industrial field of medical or medico-social nature, fosters research, stimulates provision of training in special fields and employs all necessary means to protect the health of the working people consistent with the ethical and scientific programme of the American Medical Association.

The Chemical Laboratory is concerned with the chemical investigation of the therapeutic agents presented to the medical profession. The Laboratory also serves as a clearing house for information of many new additions to materia medica, particularly the complex synthetics.

The Bureau of Investigation is a clearing house of information on patent and proprietary medicines, all forms of quackery, medical fads and fakes.

The Bureau of Health Education divides its work into (1) service to the public through physicians and medical societies, and (2) direct service to the public. The aim of both is health education of the public. This is done by answering questions, by publishing the well-known journal, *Hygeia* and by doing publicity work in various spheres.

The Bureau of Legal Medicine and Legislation looks after questions of medico-legal significance.

The Bureau of Exhibits promotes graduate medical education for physicians and disseminates health education for the public.

The Bureau of Medical Economics is engaged in the study of all phases of general economics which have a bearing upon the practice of medicine. The Bureau also endeavours to collect, tabulate, study, criticize and to prepare for publication and distribu-

tion, data pertaining to the economics of the practice of medicine; to furnish both critical and constructive information and opinions by correspondence, conferences and addresses on the several phases of medical economics; to encourage the adoption by individual physicians and medical societies of modern, sound, ethical business methods; to urge medical schools to provide medical students with information concerning the economics of medical practice.

DRIED PLASMA SHEETS IN TREATMENT OF BURNS AND WAR WOUNDS

The urgent need for an ideal coagulum has been stressed many times. It should be durable, noncontractile, pliable, nontoxic, nonirritant, bactericidal, painless, and should contain fibrin. In an article in the *United States Naval Medical Bulletin*, Mr B. Pollocle, Lieut. Commander proposes a new dressing which appears to meet these demands. Plasma sheets were prepared in the following manner: To 20 c.c. of sterile water in a Petri dish 1·5 to 2 gm. of dried plasma are added and dissolved, and then 0·2 gm. of sulphanilamide powder are added. This preparation is dried in an oven at 140°C. until a firm sheet forms, usually in 15 to 20 minutes. It is then allowed to cool and is applied directly to the burn. The plasma sheet can be made quickly by heating the preparation over a Bunsen burner until the sheet separates itself from the dish. This requires less than 5 minutes. The plasma sheet is applied to the burned area after debridement. Plasma loss is immediately stopped. Within a few minutes the plasma sheet becomes adherent, and in a few hours strands of fibrin can be seen securing the plasma sheet to the burn almost as if the burn were 'fibrin hungry". No dressing need be applied. The plasma sheets can be preserved for a period of weeks by keeping them moistened with water in a refrigerator. The author states that a dried plasma sheet overcomes most of the objections to ordinary coagulums. Plasma loss is stopped immediately. Dressings may be used but are not essential. His experience in a *limited* number of cases was gratifying.

UNITED NATIONS RELIEF AND REHABILITATION ADMINISTRATION

Report of the Sub-committee on Policies Relating to Agricultural Rehabilitation and Other Means of Raising Food Essential to Relief

General Considerations

The world food situation including both supplies and shipping requires that for the first crop year after liberation an absolute priority should be given to the production of foods for direct human consumption.

The rehabilitation of the pattern of agriculture in liberated areas and the modification of that pattern to secure agreed nutritional aims can only be undertaken when danger of actual hunger has been removed. Once this has been accomplished, agricultural production can be adjusted to meet more desirable nutritional and agricultural goals.

At the present time Unrra should concentrate its attention upon the first crop year after liberation. For that year the following factors are of primary importance:

(*a*) European agriculture apart from the devastated areas is reduced but is a going concern. It has been producing all the food consumed during the war in Central and Western Europe including the food for the German and other Axis armies. The situation in the Far East, taking the occupied countries as a whole, is not dissimilar.

(*b*) Agricultural production in these areas has been concentrated on providing food for direct human consumption. Expensive forms of animal husbandry have been drastically reduced (pigs, poultry), and there are serious deficiencies in animal products although efforts have been made in Europe to maintain milk production.

In the first crop year after liberation, the war production pattern should be continued as far as practicable. Intensive efforts should be made to secure a fuller use of the land. When, however, as in certain areas, the war production pattern had been prompted by an acute shortage of foodstuffs resulting in a disproportionate sacrifice in productivity, and provided always that other means can be found for providing essential foods, an early adjustment would be desirable to insure more efficient production.

The first responsibility in most countries from the moment of liberation will be to enable farmers to sow and harvest crops. In European countries assistance may also be required at an early date to prevent the further depletion of dairy herds. The local or national authorities will have the necessary knowledge for this task. These needs can be assessed with considerable accuracy and Unrra should, in conjunction with the national authorities, start forthwith to make provision to meet these deficiencies.

The maintenance of livestock production and herds which is of such importance to agriculture requires that the control of animal diseases by all feasible methods including the import of veterinary supplies be undertaken at the earliest possible time.

In certain devastated areas the rehabilitation problem will require special additional efforts to re-equip farms with motive power, *i.e.*, draught animals or tractors; to restore fertility to the soil; and to reconstitute essential livestock especially for milk production.

The Sub-committee agrees that the principal responsibility of UNRRA in the field of rehabilitation of agriculture and other forms of food production will be to assist local governments in providing the necessary supplies and equipment to increase production to the extent that such imports will reduce the need for relief after the second harvest. The importation of feedstuffs for milk production should have priority over the importation of feed for other livestock production. The former should receive, in principle, secondary consideration to the requirements for imports of food for direct human consumption. Where the need is urgent, the national governments should present a special case to the Standing Technical Committee on Agriculture for readjustment of these priorities.

Because of the shortage of animal proteins, fats, and vitamins, national governments or recognized authorities should take immediate steps to insure the early expansion of fisheries and of the whaling industry, and UNRRA should assist to the fullest extent possible.

In order to utilize to the greatest advantage the foodstuffs that are home produced or imported, it is recommended that UNRRA should assist the national governments or recognized authorities in restoring necessary processing facilities. It is also recommended that in order to obtain the maximum food value from bread grains the milling ratio should be maintained at high levels, *e.g.*, wheat at 85 per cent.

It is recommended that experimental stations and other agricultural institutions which can contribute to the solution of immediate post-war agricultural and food production problems should be put into a position to resume their work as early as possible after liberation.

Agricultural organizations and services, co-operative and others (including marketing and credit societies), have an important role in the provision of finance and agricultural equipment to farmers and in the collection and processing of farm produce. They should prove of special value in the immediate relief period. Wherever the national authorities desire assistance in the re-establishment of such organizations, UNRRA should give such expert assistance as it can provide.

Shortage of labour is proving a serious handicap to production in a number of countries. The Sub-committee, therefore, recommends that the reinstatement of agricultural workers should be achieved as early as possible.

In the preceding paragraphs the Sub-committee has been dealing with the short-term problems and principally those of the first crop year. The Sub-committee has studied the reports and recommendations of the United Nations Conference on Food and Agriculture and concurs generally in the conclusions reached at Hot Springs. The work of UNRRA will be confined to the short-term problems of relief and the beginnings of rehabilitation. This work will be the basis of more permanent reconstruction, and it is of the utmost importance that the actions taken by UNRRA and by the governments in that period should not hamper the long-term agricultural reconstruction programmes. It should, in so far as possible, assist towards the achievement of the objectives of the United Nations Conference on Food and Agriculture, including the progressive realization in all countries of diets adequate both in quantity and quality.

Responsibility for international action in longer term agricultural reconstruction is likely to rest with the United Nations Organization for Food and Agriculture. The Sub-committee recommends that UNRRA should take every necessary measure to secure the closest association between its own work and the activities of the United Nations Food and Agriculture Organization. The Sub-committee does not consider that it is either desirable or necessary for it to make any detailed proposals as to how this co-operation should be carried out, but considers that UNRRA should seek the closest co-operation, not only between its Council and the Council of the Organization for Food and Agriculture, but also between their respective staffs and standing committees.

PRIORITIES

The Sub-committee recognizes that UNRRA in approaching the problem of supplies for agricultural rehabilitation must relate such demands to the even more immediate need to provide food, medical supplies, clothing and other relief necessities. There is, however, a world shortage of many essential foods and war and relief demands will impose the need for continued economy in the use of shipping.

For these reasons it is of the utmost importance to obtain from the soil of the occupied countries and from sea fisheries including whaling the maximum of food in the shortest possible time.

These considerations clearly indicate the principles that should be adopted by UNRRA in the determination of relative priorities among agricultural and other food production needs.

The agricultural requirements of liberated areas include seeds, veterinary supplies, pesticides, farm machinery and implements, fuel and lubricants, fertilizers, containers and processing equipment, feed-

ing stuffs, and livestock, especially breeding and draught animals; and to this list should be added for certain maritime countries the needs of the fishing industry: boats, repair material, nets, hooks, and other fishing gear. The priorities between these various items will presumably vary from area to area. Generally speaking, the Sub-committee considers that seeds, veterinary supplies, and pesticides should receive priority immediately following that of the minimum programme for food, medical supplies, and other urgent requirements, such as clothing and soap; fuel for existing agricultural machinery and fisheries might have equal priority with fuel for transport and domestic needs. The test should be applied whether the supply of these requirements would bring early and large returns in the form of crops or of fish for direct human consumption; if so, it is recommended that UNRRA should accord the highest priority to such requirements. A further important consideration applying particularly to Europe should be to prevent the further depletion of dairy herds. Where, on the other hand, the requirements are sought for desirable but longer range objectives of agricultural rehabilitation or where the building up of such livestock as pigs and poultry would bring about competition for supplies of direct value to human needs, UNRRA must insist that the fulfilment of these needs must wait until there is no danger of a shortage of essential energy foods. The Sub-committee would not expect that any but a low priority could be granted in the first crop year to supplies for the feeding of pigs and poultry.

The Sub-committee would emphasize that in their recommendations they have attached the utmost importance to the agricultural needs of the first year after liberation. When the supply and import situation is more satisfactory, and especially when feeding stuffs can be made available and meat and fat imported in quantities sufficient to bring consumption to a satisfactory physiological level, a longer term livestock recovery programme should be put into effect.

Having regard to the importance of milling offals as a feed, the Sub-committee considers that the importation of grains should have priority over flour, where the necessary milling capacity and requisites exist in the liberated country.

Similarly, the importation of vegetable oil seeds should have priority over the manufactured products.

The Sub-committee further recommends that particular attention should be devoted to the production of those vegetables and pulses which have a high protein or vitamin content. The production of potatoes and their use for human consumption should also be increased to the maximum in liberated countries. Consequently it is recommended that a high priority should be given to imports of seed potatoes and to seeds of other vegetables such as cabbages, savoys, swedes, turnips, and carrots.

The application of fertilizers will in certain cases greatly increase food production in the early post-war period. For this reason the Sub-committee considers that everything possible should be done to restore fertilizer plants to working order, and to resume importation of the most urgently needed supplies as soon as possible.

Steps should also be taken to restore oilseed crushing plants in relation to the anticipated supplies of oilseeds. This has particular reference to feed for dairy herds.

The Sub-committee also recommends the re-establishment of factories engaged in the production of pesticides.

The provision of drying plants for meals and fertilizers should also be recognized as important in the immediate relief period.

The problems of countries in the Far East differ in many ways from those of Europe; it is to the latter that the foregoing paragraphs are principally directed, especially as they would seem to be the more urgent in point of time. There is evidence that in the Far East there has been catastrophic depletion of draught animals and this factor may affect the suggested order of priorities for imports. A similar consideration may also apply to the more heavily devastated areas of Europe.

The Sub-committee considers that UNRRA should forthwith consult with the supply authorities in order to insure that no time shall avoidably be lost in securing the most urgently needed supplies. Further, since full use of certain of the requirements for agricultural rehabilitation can only be made at critical seasons of the year, particular attention in the case of these commodities will have to be directed to advance procurement by the appropriate governmental or inter-governmental agencies in order that a full supply of the minimum requirements may be available when the time comes.

Operating Policies

The Sub-committee recommends that programmes of requirements for agricultural rehabilitation be submitted by national governments in consultation with the regional committees in such detail as the complexity of the problem requires. Arrangements should be made for revising programmes at regular intervals in the light of most recent information.

The Sub-committee recommends that national governments or recognized authorities provide for technical surveys in each area immediately after liberation. UNRRA should hold itself in readiness to provide technical assistance if invited to do so by the national government or recognized authority

established within the area. The regional organization should collate these surveys in order to insure that so far as possible comparable basis has been used. It will be possible by these means to have early verification or amendment of the estimates which have been prepared in the pre-liberation period.

The Sub-committee recommends that as a result of these national surveys, and as soon as possible after liberation, national production programmes should be developed by the national governments or recognized authorities of the acreages which will be sown with the various crops and of the output expected to be achieved from agricultural and fishery production. National governments or recognized authorities should base their estimates of requirements of agricultural supplies upon these production plans.

It is the national authorities which can best assess the needs of their own countries, and the national representatives, in collaboration with the regional officers of UNRRA, will be able to provide a realistic list of requirements and an appropriate recommendation on priorities.

By these means programmes for agricultural materials which fall within the scope of UNRRA will be related to the detailed needs of each territory in relation to particular crops. They will show whether there are special features of the national production programmes to which it may be desirable to draw attention, particularly if these programmes call for specialized use of fertilizers or other imported materials. Representatives of the countries receiving supplies through UNRRA should agree to develop plans for the control of imported agricultural materials in a manner designed to insure the fullest attainment of the production programme. Such countries should also develop plans for assembling and distributing agricultural products to insure that food needs of the area are met to the maximum extent.

It is recommended that each national authority should be provided by UNRRA with such information as is available concerning production surpluses in nearby areas in order that the total supply of essential foods may be attained to the maximum extent in relation to factors, such as the availability of imported rehabilitation materials. For instance, it may be possible to use the anticipated surpluses in one area to remedy the deficiencies of an adjacent area. The regional organizations will probably be found to be the most suitable instruments for carrying out this work of co-ordination.

The task which UNRRA will have to undertake will require the appointment of technical officers to serve in its headquarters and regional offices and in the field. So far as technical assistance in the field may be desired by the national authorities, UNRRA should undertake to do this.

The Sub-committee desires to point out that in some countries the national agricultural organization will have an adequate staff of technicians at its disposal and will not so much require assistance for normal agricultural duties as for field officers who are specialists in the critical interpretation of production in relation to requirements.

The Sub-committee notes and concurs in the recommendations made by Sub-committee I of Committee I to establish a Standing Technical Committee on Agriculture with regional sub-committees. Having regard to the importance of the rehabilitation of agriculture in the immediate post-war period, the Sub-committee recommends that those committees be established and organized as soon as possible.

BOOK REVIEWS

Inorganic Plant Nutrition (Prather Lectures at Harvard University).—By D. R. Hoagland, Ed. 1944. Published by Waltham, Massachusetts, U. S. A., the Chronica Botanica Co.; Macmillan and Co., Ltd., Calcutta, Price $4, Pp. 1-177 and 28 illustrative plates.

The book under review is volume XIV of "A new series of Plant Science Books," published by the Chronica Botanica Company of Waltham, Mass., U. S. A., and Edited by Frams Verdoorn. It contains seven lectures on the Inorganic Nutrition of Plants given at the Harvard University under the Prather Lectureship. The broad headings of the seven lectures are:

(1) A survey of problems of plant nutrition; (2) Micronutrient chemical elements and plant growth; (3) The absorption and accumulation of salts by plant cells; (4) Upward movement and distribution of inorganic solutes in the plant; (5) The growth of plants in artificial media in relation to the study of plant nutrition; (6) Some biochemical problems associated with salt absorption; and (7) Aspects of the potassium nutrition of plants as illustrative problems of the system, soil-plant-atmosphere.

Inorganic nutrition of plant is a subject in which much work has yet to be done. As the author has stated in the preface, the purpose of the small volume is to present a general prospective of several important aspects of the field of plant nutrition. In these series of lectures the author who is a prominent worker on plant nutrition, has naturally emphasised that aspect of plant nutrition with which he has most direct contacts. The relation of inorganic solutes derived from root medium to the growth of the plant has been discussed, including the role of soil colloids. The author has stressed the importance of soil acidity and alkalinity in relation to plant growth. The part played by the so-called micro-nutrient chemical elements like Copper, Zinc, Manganese, Boron, Cobalt, Molybdenum and Selenium, in plant growth, has been discussed. Apart from the diseases which may be caused to plants by the deficiency of micronutrient elements, animals can suffer from deficiency diseases because the vegetations consumed does not supply enough or more of the elements that function in minute quantities. The author has discussed the accumulation of salts by plant cells particularly by barley roots and has pointed out the importance of the study of artificial cells and membranes. The work of the author and Davis on the fresh water alga "Nitella", which produces multinucleate cells is very interesting. The review of the works on the absorption and accumulation of inorganic solutes by excised roots have been followed by a critical review of the upward movement and distribution of inorganic solutes in the plant. The general problem of translocation of inorganic salts in the tissues of plants is very complicated and the theories evolved to explain this type of translocation are various and still highly controversial. The work of Stout and Hoagland (1939) who performed a series of experiments with radioactive tracers of phosphate, bromide and potassium ions on several species of plants showed that the upward movement of solute in the wood was far more rapid than in the bark, but a rapid lateral transfer of solute from wood to bark took place whenever the two tissues were in contact. The author has also surveyed some of the physiological aspects of the inorganic nutrition of plants as they are offered for examination under controlled conditions of artificial culture technique. The author has tried to bring out that artificial culture methods, including climatic control in appropriate cases, as well as control of nutrient media will render important service to plant technique. The author has pointed out that at the heart of the whole question of salt accumulation in its relation to biochemistry is the nature of the energetic coupling of metabolism to the active transport of salt. The author feels, that progress in understanding the mechanism of salt accumulation will depend largely on advancing knowledge of the biochemistry of respiration, together with a correlation of biochemical transformations with the maintenance of organised structures in the protoplasm.

In the final lecture the author has discussed critically the different aspects of potassium nutrition in plants, and has shown that the potassium supply has indirectly a relation to the respiration of plant tissues. It has been pointed out that the climatic environment influences the requirements of the plant for potassium, or its ability to absorb potassium. The interesting fact is that no indispensable organic combinations of potassium have been discovered and that nearly all potassium exists in inorganic form.

There are twenty-eight valuable illustrative plates in this volume, drawn from the experiments of several groups of Californian workers. Although the book is not a complete survey to the vast number of contributions in the field of plant nutrition, it has presented in a compact form, a number of important problems. It is hoped that the book will be useful to all students and research workers on plant nutrition.

A. T. S.

Agriculture in India.—By Nabagopal Das, Ph.D. (Econ. Lond.), I.C.S. To be had of the Book Exchange, Price Re. 1/-.

Dr Nabagopal Das has already made his mark as a writer of several books on current economic and industrial problems. "Agriculture in India" is a little monograph of 55 pages which the author has done well to write for the general readers at a time when average man in India is beginning to realize the seriousness of her agricultural backwardness. The author has not attempted a thorough discussion of the problem, and this is also not possible within the small compass of a monograph, but he has presented enough facts to convince the lay reader of the magnitude of India's agricultural problem and the need for thorough agricultural development along scientific lines in the immediate future. The book is readable and has general educative value.

S. N. S.

Beyond the Microscope.—By Kenneth M. Smith, F.R.S. Published by Penguine Books.

Viruses and virus diseases have attracted widespread attention during recent years. Although viruses and virus diseases are as old as life itself on this planet, it is only recently that the mystery shrouding these invisible micro-organisms is begining to be lifted. The nature of, and the diseases

caused by, such micro-organisms which have hitherto baffled all attempt to see them with the help of the most powerful microscope using visible light have formed the theme of the little book, "Beyond the Microscope", under review. *The Penguine Books* has an unerring judgment in its choice of authors for special monographs, which has also been adequately reflected in the present case. Dr Kenneth M. Smith, Director of the Plant Virus Research Station at Cambridge University and author of this monograph and several others on entomology and plant viruses, has worked most of his professional life on plant viruses. His account, although designed for popular readers, has accordingly every stamp of authority and an advantage of first hand information. Besides, he has told his story—and story-like the book would read—in a fascinating and elegant way that easily appeals to popular imagination.

The book is divided into ten chapters, each devoted to a special topic relating to viruses. The various discussions introduced include such subjects as viruses in every day life, viruses in farm and garden, viruses in the tropics, study of viruses in the laboratory, viruses and tumors, viruses in time of war and peace, combating the viruses etc. The book further contains six illustrative photographs. The book is an invaluable possession for any one intending to know the nature of viruses and virus diseases.

S. N. S.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

A SIMPLE SUBSTITUTE FOR PERFORATED GLASS DISCS IN SOIL PERCOLATORS

The perforated glass discs in soil percolators can be replaced by discs made with ordinary wax (m.p. 60°C).

These can be very easily prepared by melting calculated weight of wax in warm water with a known surface to give it the desired thickness and allowing the oily liquid on the top to cool: When cool, the wax solidifies giving a very uniform sheet of wax. Discs can be cut very easily by marking the sheet with a sharp pin and giving slight twists. The holes can be bored easily.

Owing to difficulties of supply of glass discs we are using these discs for soil studies. They are entirely satisfactory. The advantages over glass are the following:

(1) They are not broken so easily as the glass ones.

(2) They are not attacked by ordinary chemical reagents *i.e.* acids and alkalies.

(3) They are cheap.

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Abhiswar Sen

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PNEUMATIC TIDE-GENERATING MACHINE FOR EXPERIMENTING WITH MODEL TIDAL RIVERS

In a laboratory model of tidal river the tides are artificially generated usually by dipping a drum or 'plunger' in the downstream end reservoir of the model channel. The plunger is dipped or withdrawn with pre-determined speeds controlled by a suitably contoured cam which is figured according to the given tidal curve. For a large model the plunger becomes quite large and the machine unwieldy. In the Severn model designed by Prof. Gibson[1] the plunger has a size of 8½ ft. × 1½ ft. × 2½ ft.—In another method,[2] water in the downstream reservoir is fed and withdrawn through water valves and floats to give proper rise and fall of the level at the seaward end of the model.

In the present pneumatic tidal machine the downstream tank is partially covered and partitioned out into two compartments with a vertical wall having communication holes at the bottom (fig. 1). Water is first filled in the model up to the required level. Then by introducing air from a compressed air reservoir the level of water in the tidal tank (A) is depressed and water is forced out across the bottom holes (D) into the channel-end (B), giving the swell of a tide. By releasing the air through an exhaust the water in the tidal tank rises again and there is an ebbing in the channel.

It is important that the closed tidal chamber (A) should be air tight above the water level. If the structure is all masonry the internal walls and the cover should be well coated with cement, or better

still with a layer of varnish. For perfect assurance against air leakage, a thin gauged sheet metal tank may be incorporated inside the closed masonry tank, the masonry enclosure will protect the thin metal tank from its tendency of bulging under pressure.

This pneumatic method of generating artificial tide in a model tidal experiment eleminates any mechanically moving heavy part. Quite low pressure is necessary in the tidal tank, the level difference of water in the tank (A) and in the free channel side

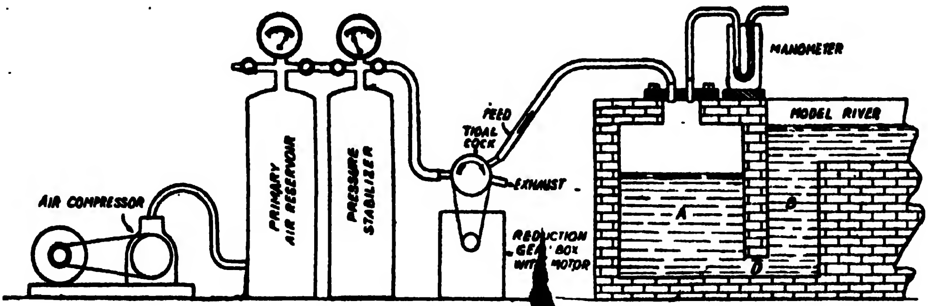

FIG. 1. General arrangements of th[illegible]de-generating device.

(B) representing the pressure in the tidal tank, which amounts only to some fraction of a pound per sq. in. The volume of air required is, however, large, depending on the size of the model and tidal range. But considering the pressure and volume together, and the time of a complete tidal cycle, the power involved is quite small, so that the compressed air outfit is not large.

The intake and exhaust air lines are provided with suitably figured openings in the cock in order that a given tidal action is produced by the controlled rates of feed and exhaust. The cock consists of a cup (stator) and a cone (rotor) as usual. The present rotor is about 2 inch in diameter and 2 inch in height and is made of cast iron. The rotor cone is hollow and is cut with two openings or slots as shown in fig 2. The opening moves on slowly (according to the time-scale of the model experiment) against a slit in the stator cup of the cock. The slit then leads to the nozzle. The figure of the opening in the rotor is derived for a given tidal curve (the present figure represents that for a particular tide at Kultigong). The opening represents the rate of rise $\frac{dh}{dt}$ of the gauge level h with time t and the values are derived from the t, h curve of the given tide. The width of the slot at any instant is given by $y = m\frac{dh}{dt}$, where m is any constant suitable for the size of the rotor. This approximately represents the feeding (or exhausting) rate of air for the tidal tank, and the opening in the rotor is cut according to this rate. Some corrections, however, are necessary as the channels have not rectangular cross section and that the free surface of water in the channel goes on increasing as the water rises up. The variation, however, is small compared with the total mean surface of water in the tidal section. Some minor, cut-and-try retouching may be necessary on the figure of the opening. Auxiliary cocks and pressure controls are also helpful in obtaining accurate representation of a given tide.

The time of tidal cycle is controlled by the rotation of the cock which is driven by a reduction gear and a small electric motor. The nature of the tide is controlled by the figure of the opening in the tidal cock. And the tidal range or amplitude is controlled by the feed pressure of the compressed air across the cock.

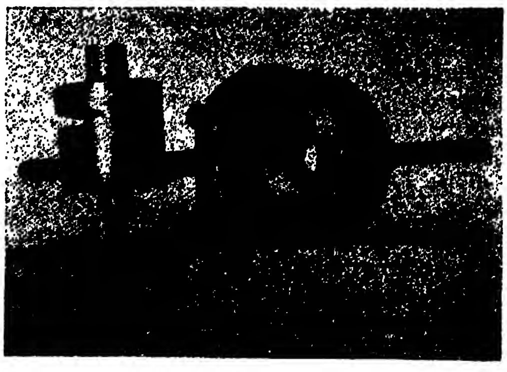

FIG. 2. The tidal cock, dismantled.

Work is in progress and details will be published elsewhere.

My thanks are due to Prof. M. N. Saha, F.R.S., and Dr N. K. Bose, Ph.D., Director of the River

Research Institute, Bengal, for taking keen interest in the work. I am also thankful to the Irrigation Department of Bengal for providing funds to carry out researches in River Physics in this Laboratory.

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[1] A. Gibson, Report of the Severn Model, Manchester University.
[2] *Annual Report* (p. 18, 1940-41) of the Central Irrigation and Hydrodynamic Research Station, Poona.

COEFFICIENT OF RADIATIVE RECOMBINATION OF $N_2^+(X')$ AND e

In a recent note by the author the value of the recombination co-efficient of N_2^+ (X') ions and electrons in the nitrogen after-glow was computed from the rate of decay of glow as observed by Rayleigh.[1] The value was found of the order of 10^{-14} cm^3 per sec. According to Mitra's theory[2] of active nitrogen this is the co-efficient of recombination of the ion and the electron by the three-body collision process $N_2^+ + e + N_2 \rightarrow N_2$(B-state) $+ N_2$(A-state) in course of which the characteristic spectrum of active nitrogen—the first positive bands—are emitted. It is obvious that the value of the co-efficient of radiative recombination $N_2^+(X') + e \rightarrow N_2 + h\nu$ must have to be much smaller than the value 10^{-14} cm^3 per sec. as otherwise, the electrons and the ions will disappear rather by this process than by the three-body collision process. That the co-efficient of radiative recombination is small is seen from the following considerations:

The probability of radiative recombination of an electron and a positive ion is proportional to the probability of the opposite process namely ionisation by light absorption $(N_2 + h\nu \rightarrow N_2^+(X') + e)$. In fact, according to Milne[3] the two are related by the formula

$$Q_e = Q_a \frac{2(h\nu)^2}{m^2 v^2 c^2},$$

where

Q_a = cross section of light absorption,
Q_e = cross section of light emission,
m = mass of electron,
v = velocity of electron,
c = velocity of light,
ν = frequency of emitted radiation.

In order to find the cross-section of radiative recombination we require the cross section of light absorption for process $N_2 + h\nu \rightarrow N_2^+(X') + e$ and the value of v. Unfortunately, however, the value of Q_a for the above process has not been determined. Nevertheless we can make some idea about its probable magnitude from the following data.

Absorption experiments in the extreme ultra violet show that while light absorption leading to the ionisation process

$$N_2 + h\nu = N_2^+(A') + e \text{—(I)}$$

is quite strong, that leading to the ionisation process

$$N_2 + h\nu = N_2^+(X') + e \text{—(II)}$$

is extremely small. $(N_2^+(A')$ is the excited state of the normal ion $N_2^+(X')$. (See, for instance, energy level diagram of N_2 in Molekülspektren and Molekülstruktur, Herzberg, page 327). In fact, Hopfield[4] who was the first to study the extreme ultra-violet absorption of N_2 did not observe the absorption in the region $\lambda 794$ which corresponds to reaction (II). In a more recent experiment by Price[5] 'an absorption continuum was found near the region $\lambda 794$ but the bands going to it could not be identified with the type of bands one would expect to approach the gound state of N_2^+'. Worley and Jenkins,[6] however, in 1938, observed that there was a continuum corresponding to reaction (II) with a few tenths of a mm. of N_2 at N.T.P. Worley and Jenkins do not give any quantitative data regarding the value of the absorption co-efficient, but it appears to be very small. Compared to this Takamine[7] obtained absorption continuum for the reaction (I) strongly with only a few hundredths of mm. of N_2 at N.T.P. From these results one is justified in assuming that the cross-section of light absorption for the ionisation process (II) is much less, more than one order at the least (say one hundredth) than that for process (I). Now an approximate value of the cross-section for reaction (I) has been obtained by Bhar by applying Kramer's formula; the value found is $1{\cdot}9 \times 10^{-18}$ cm^2. The cross-section of absorption for reaction (II) may therefore be taken as $1{\cdot}9 \times 10^{-20}$ cm.^{2} Assuming electron energy to be $\cdot 5$ *e.v.*, $v = 42 \times 10^7$ cm/sec (which is by no means too high a value for electrons derived from powerful discharge) we obtain $Q_e = Q_a \times 0{\cdot}96 \times 10^{-3}$

$$\therefore Q_e[N_2^+(X') + e \rightarrow N_2 + h\nu] = 1{\cdot}82 \times 10^{-23} \text{ cm}^2$$

And, since the co-efficient of recombination is related to the cross-section for electron-capture by the equation $\alpha = Q_e \times v$ we have for reaction (II), $\alpha = 7{\cdot}6 \times 10^{-16}$ cm^3/sec. This is about two order less than the co-efficient of recombination by the three-body collision as calculated from Rayleigh's experiment.

In view of the uncertainties in the values of the various quantities involved in the calculation, the value of α obtained is to be considered only as a rough approximation. But the fact that the probability of ionisation of N_2 to $N_2^+(X')$ by light absorption is extremely small, is an experimental

one, and it is on this that the result obtained above is mainly based.

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[1] Rayleigh, *Proc. Roy. Soc., A.*, *176*, 1, 1940.
[2] Mitra, S. K., SCIENCE & CULTURE, *9*, 49, 1943-44 and *10*, 133, 1944 *Nature*, *154*, Aug. 12, 1944.
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[4] Hopfield, J. J., *Phys. Rev.*, *36*, 789A, 1930.
[5] Price, W. C., *Phys. Rev.*, *48*, 716, 1935.
[6] Worley and Jenkins, *Phys. Rev.*, *54*, 305, 1938.
[7] Takamine, Suga and Tanaka, Sc. Pap., *I.P.C.R.*, *34*, 854, 1938.
[8] Bhar, J. N., *Ind. Jour. Phys.*, *12*, Part V, 1938.

ON THE ORIGIN OF EXTRA REFLEXIONS IN THE LAUE PHOTOGRAPHS OF PHLOROGLUCINE DIHYDRATE CRYSTALS

BOSE[1] has recently observed that in the Laue photographs taken with X-rays parallel to the *c*-axis of crystals of phloroglucine dihydrate a few extra spots appear in positions agreeing with those expected for the two-dimensional grating. These spots have further been found to be produced by monochromatic radiations and not by the white radiation. Bose has not offered any explanation regarding the origin of these extra spots, but has called them secondary extra reflections on the assumption that they are similar to some extra reflections observed in the case of diamond and called secondary extra reflections by Jahn and Lonsdale.[2] He has further stated that since the extra spots due to phloroglucine dihydrate are produced only by those portions of the crystal which are free from internal strain, these facts contradict Lonsdale's theory that the secondary extra reflections from diamond are due to internal strain in the crystal. The object of the present note is to point out that there is a fundamental difference between the nature of the secondary extra reflections from diamond and that of the extra reflections from phloroglucine dihydrate observed by Bose, and also to offer an explanation regarding the origin of these reflections observed by Bose.

It has been pointed out by Jahn and Lonsdale that the position of the centre of the triangular pattern constituting the secondary extra reflection from (111) planes of diamond shifts as the deviation from the Bragg angle is changed so that the Faxen formula is always approximately satisfied. On the other hand Bose has observed that the positions of the extra spots due to phloroglucine dihydrate do not change appreciably while the Laue spots move over considerable distances. These facts clearly indicate that the angle $2\theta_m$ between the incident beam and the direction of extra reflection remains constant in the case of phloroglucine dihydrate even when the glancing angle is changed, but this angle changes in the case of diamond with the change of the glancing angle. Hence the assumption made by Bose that the extra reflections observed in the two cases are similar is not correct, and consequently, his inference that the facts observed by him are contradictory to the hypothesis put forward by Lonsdale to explain the origin of secondary extra reflections from diamond is also not correct.

As regards the origin of the extra spots observed by Bose it has to be pointed out that mosaicity of the crystal can produce such extra spots under certain circumstances. When the lines of intersection of planes in successive thin layers of the mosaic block are parallel the Bragg relation may be satisfied by the planes in a particular thin layer although the glancing angle for planes in the other layers is either smaller or larger than θ_B, the Bragg angle. This layer in that case will give rise to an intense Bragg reflection while the intensity of the Laue spots due to the other thin layers will be very small, because the intensity of the corresponding bands in the white radiation is very small in comparison with that of the characteristic radiation. A Laue spot will, however, be produced by the portion of the crystal which is free from mosaicity and the effective thickness of which is much larger than that of any thin layer of the mosaic block. As the spacings of the planes in the different layers of the mosaic block are identical the Bragg reflection will occur in the direction making an angle $2\theta_B$ with the incident beam for all settings of the crystal for which the Bragg relation is satisfied by the planes in anyone of the layers in the mosaic block.

In the case of diamond, internal strain in the crystal may alter slightly the spacings of the planes, and the extra reflections will occur in directions making different angles with the incident beam so that the Bragg relation for the altered spacings is satisfied in those particular directions. Thus imperfections of different types may give rise to extra reflections of different nature and those observed in the case of phloroglucine dihydrate are due to the mosaicity of the peripheral portions of the crystal.

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Calcutta, 7-10-1944.

[1] Bose, C. R., *Proc. Nat. Inst. Sc.*, *10*, 201, 1944.
[2] Jahn and Lonsdale, *Nature*, *147*, 88, 1941.

METHODS FOR THE REMOVAL OF THE TOXIC AND INHIBITORY PRINCIPLE OF VARIOUS SOILS

APART from the case of the fertile soils by the side of the river beds and in the delta regions, there are some soils which exhibit total infertility. It has been established that the inability of a soil to promote the plant growth, cannot be entirely attributed to the absence of nitrogenous substances, nutrient salts and soil acidity but that only the micro-organisms are intimately connected with the infertility of the soil.

These micro-biological agents are further recognised to bring about the toxicity during the decomposition of organic Detritus. The methods employed to prevent such inhibitory principles of the soil on the part of the plant-growth are summarised as follows:

(1) The soil, heated to 40-50 degrees and gradually cooled.

(2) The soil heated with alcohol.

(3) Heating with methylated spirit.

(4) Heating with Acetone.

(5) Partial sterilization also can be applied but not so successfully.

(6) A series of papers published in the literature concerning soil chemistry established that solar radiation has got a tremendous effect in promoting the growth by removing the inhibitory principles. The solar radiation effect on the removal of soil toxicity is studied and discussed here. Thus the common experience of the agriculturist is fully justified in tilling the land and leaving for sometime exposed to the sun before he waters and seeds it. This involves a photo-chemical effect brought in favour of the micro-organism by enabling itself to grow and multiply in a nitrogeneous atmosphere which essentially requires sunlight. In fertile soils the decomposition of the organic bio-humus is absent and the micro-organisms multiply in number by a spontaneous growth. But the fact that some soils cannot promote plant growth means that such a humus-decomposition is associated with the metabolic origin of the particular soil.

Black gram is found suitable for studying the removal of inhibitory principle in a variety of soils and the Table I given below shows the rate of growth dependent on the nature of the soil at the ordinary temperature.

Again the composition of the soil also plays an important role in promoting the plant growth. A preliminary set of analyses of these different soils gave the following results (Table II).

TABLE I

No.	Source and specificity of the soil	Weight taken	Period of exposure to sunlight	Time taken for the first appearance of germination
1.	Sea-side sandy soil	about 10 lbs.	48 hours	about a week
2.	Coarse rocky soil	,,	48 ,,	,, 15 days
3.	Lake clay soil	,,	60 ,,	,, 3 ,,
4.	Well clay soil	,,	48 ,,	,, 3 ,,
5.	Pit clay soil	,,	48 ,,	,, 2 ,,
6.	Canal clay soil	,,	48 ,,	,, 1½ ,,

TABLE II

No.	Source and specificity	Amount of mineral matter present as particles of various sizes	Amount of organic matter	Amount of soil made of inorg. salts	Soil atmosphere made up of different germs	Micro-organic population
1.	Sea-side soil	65%	10%	12%	12%	2%
2.	Coarse rocky soil	70%	6%	14%	10%	2%
3.	Lake clay soil	45%	20%	20%	14%	1%
4.	Well clay soil	40%	25%	20%	14%	1%
5.	Pit clay soil	45%	25%	25%	5%	1%
6.	Canal clay soil	30-35%	25%	25%	15%	1-2%

Further work is in progress.

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Christian College,
Guntur, 5-9-1944.

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PLANNING AND POLICY

SINCE his assumption of office in September, Sir Ardeshir Dalal, Member for Development and Planning, had a number of occasions to speak on the question of industrial planning and development. Particular mention may be made of his speeches delivered in connection with his first press conference held early in October and on the occasion of the first meeting of the Policy Committee on Industries, a summary of which appears elsewhere in this issue. More than ordinary interest attaches to the statements and views he has given expression to, which may be safely accepted as a fair and authoritative indication of the Government attitude and policy, if any, with regard to the pressing problem of post-war industrialization of India.

Meanwhile, Sir M. Visvesvaraya has also come forward with his own five-year plan and suggestions for reconstruction which form the subject of a little pamphlet "Reconstruction in Post-War India" issued by the All-India Manufacturers' Organization. Although unofficial in nature, the views and suggestions contained in the pamphlet come from one who has been intimately associated with all the industrial movements of this country for the last quarter of a century and who may be rightly said to have first imported from the West the very idea of planned economy for India as the only solution of her abject poverty and ridiculously low standard of living.

The considered views of the two great industrialists, one speaking under the limitations of his official position and other representing the unofficial point of view, provide new material for discussion, and we offer no apology for reverting to the old but renewed question of planned industrial development of India.

Progress in Government Planning

At his first press conference, the Member for Planning and Development revealed that the Government of India had already made considerable headway in certain branches of planning, such as the development of roads, railways, education, agriculture, etc., and that schemes have been prepared and sanctioned. The Sargent Scheme for educational reconstruction, for instance, has been generally accepted as providing the outline of India's future educational development along sound lines. The Government have contemplated a large expenditure of Rs. 400 crores on road development and have projected expansion in railways at a capital expenditure of Rs. 300 crores. Dr Burns' report on the technological possibilities of agricultural development, although not comprehensive, represents, however, an honest effort to assess the agricultural problems of India from a technical point of view and to suggest the most obvious remedies. The Imperial Council of Agricultural Research, we are further told, is also seriously considering the whole subject of agriculture and animal husbandry, and the Government have in the meantime appointed a number of sub-committees to examine, and report on, such questions as the stabilization of price, agricultural indebtedness, land utilization, fish and milk. The Government have also expressed their desire to set up a Central Technical Power Board and a Central Irrigation Board.

These are sufficient indications, as Sir Ardeshir would have us believe, of the Government's earnestness to go ahead with their planning programme. But after the Government have assumed complete responsibility for undertaking planning for this country, it is not enough to be told that Government are taking this planning business earnestly. The points to be made clear are how far the work of the Government proceeds along proper and sound lines, whether the principal issues and the fundamental problems of reconstruction are being given due prominence, whether the lines of development the Government propose to pursue are best calculated

to promote national interest and lastly, whether the plans in individual subjects, drawn up separately, form parts of a co-ordinated planning for all-round economic and social uplift. The object of planning for reconstruction, as we understand it and as it is accepted in other countries which have profited by planned development, is to raise a country's economic efficiency to such a level as guarantees a reasonable standard of living for all, opportunities and employment for all, and some measure of social security to safeguard the subsistence needs of all. It is most important to enquire whether the Government, while proposing a planned development of India, have accepted the above criterion as the cardinal object of planning or have they attached a different meaning to the term. In that case, have they defined that object and explained in clear and unambiguous terms their policy which should guide and determine the entire planning activity? It is on these criteria that Sir Ardeshir's speeches or those of any other spokesman in authority should be judged.

Most of the schemes and proposals referred to above and drawn up so far are unco-ordinated individual schemes and represent mainly unproductive lines of development. The wisdom of showing primary interest in such schemes as the development of roads and railways, some of which are likely to lead to heavy unproductive debts, and sanctioning huge sums of money for their execution may well be called in question. In fact, Sir Visvesvaraya has sharply criticized such practices of sanctioning individual schemes and has raised fundamental objection to such procedure. Nothing is more erroneous than proceeding with schemes framed in isolation before the entire range of development has been envisaged and carefully planned. Moreover, these lines of development though important do not represent the country's prime necessities today whose fulfilment should bring prosperity to the people. And yet the Government have of late been loudly advertising these plans and taking active interest in their execution.

On the other hand, the urgent question of the development of industries, particularly the heavy and basic industries, has received little or no attention and has been ignored. The Government have curiously enough maintained a studied silence and have evaded the issue on constitutional grounds. They have justified their inaction on the plea that industries are Provincial subjects and that the Centre is not expected to meddle in questions relating to them. And this, despite the knowledge that vigorous drive for industrialization is not possible except under a strong and planned central lead. In fact, planned effort means such a central lead. We have ample confirmation of this truth in the fact that the Central Government of India on innumerable occasions, under the present emergency of war, have acted in their supreme capacity in complete disregard of such Central and Provincial delimitations with great advantage. Industrial development of this country with which the economic well-being of the people is inseparably connected is an emergency of no mean order.* The fact is inescapable that while Governments of other countries have promptly acted to meet similar emergencies arising in their respective countries, the Government of India have not only preferred to remain inactive, but have attempted to shirk responsibility on such artificial pleas. The creation of the Department of Planning and Development and the appointment of one of the signatories of the Bombay Plan as its Member were interpreted in several quarters as signalling a change of Government attitude with regard to their industrial policy. The public naturally expected some clarification of this policy, especially as it applies to the question of setting up of heavy industries. This expectation has hardly been fulfilled.

Plans for the Training of Technical Personnel and Industrial Panels

The Planning Member has, however, informed us that the Government have proposed to send a large number of men for training in the near future to the United Kingdom and the United States of America. This is undoubtedly a step in the right direction. We share his views when he says that 'the most essential preliminary step was the training of our future scientists, engineers, geologists, doctors, agriculturists, educationists, administrators, etc., in the innumerable different jobs for which they would be required'. Likewise the suggestions for the establishment of a very high grade technological institute on the lines of the Massachusetts Institute of Technology in the U. S. A. and of an All-India Medical Centre will be approved. Sir Visvesvaraya has also pleaded in his booklet for the establishment of an Institute of Higher Technology on the model of the M.I.T. Further, Mr John Sargent, the Educational Advisor

* Sir Visvesvaraya estimates that the average income from industries in normal years is Rs. 15 per head of population in India. In the United Kingdom and the U. S. A., the corresponding figures are Rs. 800 and Rs. 1,000 respectively. Whereas 7·1 per cent. of the population in England and Wales and 22 per cent. in the U. S. A. are engaged in agriculture, India has about 67·2 per cent. of her population dependent on agriculture. In no civilized country has the proportion of agricultural population exceeded 33 per cent. Even in the face of such facts, the ex-Viceroy had no scruples to say that 'India is, and for a long time yet, likely to be, mainly an agricultural country'. For, otherwise how can the chronic poverty of this country, so essential for the prosperity of the country of his birth, be perpetuated?

to the Government, recently visited the U. K. and the U. S. A. to investigate to what extent facilities for the technical training of Indians would be available in those countries. Necessary as these steps are, we are at a loss to understand how one can plan for the training of technical personnel before plans for the development of basic and manufacturing industries requiring such personnel are ready. This is putting the cart before the horse.

So far as the whole question of the development of industries is concerned, the Hon'ble Member has given us nothing more than the bare statement that the Government have further proposed the creation of a number of panels for industries, each composed of a permanent officer of the Planning Department and one or more experts according to requirements, and entrusted with the task of investigating the problems of the development of individual industries or groups of industries. These panels, it is understood, would act in close liaison with the Supply and Industries and Civil Supplies Departments. The final plans will be worked out after due consideration of the findings and recommendations of these panels and the various development committees which the Provinces have been requested to set up in their individual capacities.

We are, however, not in a position at present to judge the merit of the proposed procedure, as detailed information regarding the nature and constitution of such industrial panels is lacking. Perhaps it may be desirable to introduce the panel system; but much depends on the selection of industries and the nature of the Government's industrial policy in the post-war period. In fact, regarding the creation of panels for some heavy industries, such as ship-building, air-craft, manufacture of large electrical machinery, plastics, dye-stuffs, etc., Sir Ardeshir's remarks have already proved far from encouraging. The individual industrial concerns, we are told, will be left to themselves to make their own arrangements with regard to such industries. Panels for such industries, even if created, will do no more than suggest in a very general way the feasibility and location of such industries. So even if the development of industries receives any encouragement, the Government are more likely to concentrate on light and less important industries and ignore the claims of heavy and basic ones for which excuses on either technical or economic grounds will not be difficult to advance. That is why industrialists and political leaders of the country have repeatedly pressed the Government for a clear statement of their post-war industrial policy, but without success.

Industrial Expansion Discouraged

Sir Ardeshir, however, entertains optimistic views regarding the attitude of His Majesty's Government to the question of industrial development of India and appears to be confident of their appreciation of India's needs and aspirations. "It is a matter of gratification to observe" says he, "that so far as His Majesty's Government are concerned, there is a clear appreciation of our needs and aspirations." In support of his views he quotes a few lines from Mr Amery's speeches delivered before the Institute of Export and the East India Association. At a meeting of the latter, Mr Amery is reported to have said,

> "I can say that the Government of this country (Britain) only wants to see Indian industry developing to the fullest. The last thing the industrialists of this country have in mind is the idea that the British exports industry can best prosper by India being held back in the course of her industrial development."

Sir Ardeshir is to be congratulated on his effort to discover in these words the germ of positive assurances. But we are hardly prepared to accept them as such, knowing full well that they come from the mouth of a die-hard imperialist of the stamp of Mr Leopold Amery.

The Government's attitude in the past was one of uninterrupted obstruction and discouragement. Even during the present war when development of heavy industries was considered essential in the interest of the United Nations by several experts and strategists, His Majesty's Government stubbornly resisted any such development lest it should jeopardize British commercial and trade interests in India when victory comes. Conferences were held and missions were invited at the expense of Indian tax-payers to discuss the question of India's industrial development in so far as it contributes to the war effort, but the decisions were taken secretly and the reports of their deliberations were not published. Sir Visvesvaraya cites, in his booklet, a number of instances of similar missions and conferences which have already elicited bitter criticism in the Indian press. The report of the Roger Mission, as he writes, remains a sealed book to the Indian public to this day. The Mission consisted of a large number of industrialists from England and the Dominions, but none from India. Even the trusted representatives of the Indian people were not taken into confidence when the Mission's proposals were formulated. The report of the Grady Mission was also suppressed. Similarly, while well-known manufacturers from other countries were freely allowed to take part in the Eastern Group Conference, India was represented by a few seasoned Government officials and not by the trusted representatives of Indian manufacturers. In fact, the Government were at pains to explain away the visit of Mr Guy Locock, the representative of the British Board of Trade, to the Eastern Group Supply Conference session held in India in October, 1940. The real purpose which inspired the British Board of Trade to send their re-

presentative to the Conference is briefly referred to in a report of the *Railway Gazette* of London, from which Sir Visvesvaraya quotes the following extract,

"As the Board of Trade representative on the Mission, he (Mr Locock) was entrusted with the task of appraising future efforts on British industry of the war production expansion now being undertaken, always keeping in mind the necessity for giving priority to vital war needs. . . . . At the same time Mr Locock holds the view that no steps have been taken to expand production as a result of the Mission's visit which are not essential for war purposes and that on the whole post-war interests in India of British industry are not likely to suffer so greatly as was at one time expected."

These are sufficient instances—and many more can be cited—to indicate clearly the negative attitude of the Government towards industrial expansion of the country. Meanwhile, nothing of importance has happened to foreshadow a substantial change in the Government's industrial policy and to make us interpret Mr Amery's verbal statement as definite assurances on which to work.

Only the other day, a correspondent of the *Hindu* (November 4, 1944), writing from London, drew attention to the possibility of an intensive competition between British and American manufacturers for post-war markets. Preparations for a huge American export trade in the post-war period have already caused grave anxiety in Britain, and recently *The Manchester Guardian* devoted a full editorial article protesting against such uneasy trends in American commercial policy. Complaints that Britain is lagging behind U.S.A. in export plans are now frequently lodged, and from several quarters the demand has been made that the Government should explain at least the broad features of their future commercial policy. An American commentator, on the other hand, would have us believe that 'more than 1,000 British salesmen with passports and special privileges are now roaming through all the friendly nations, offering goods of British manufacture for post-war delivery.' With regard to the menace that American business men who produce better and cheaper articles are least expected to refrain from producing and selling them, *The Manchester Guardian* writes:—

". . . . The United States Commodity Credit Corporation has just announced plans for the resumption of cotton and wheat export subsidies designed to put American surpluses on the world market at artificial prices. Similar 'equalization' or dumping schemes for textile exports are authoritatively reported to be under consideration in Washington. Other facts mentioned in this connection are firstly Admiral Land's statement that the American Merchant Marine would have to be maintained 'by parity payments' to equalize operating costs with those of competing foreign ships; secondly, Mr Harry Hopkins' demand that American loans should be only spendable in the United States; thirdly, 'the propaganda campaign of American exporters in the Indian Press introduced by a series of full-page advertisements signed 'Issued by the Government of the United States.' "

". . . . But how shall we stand, if we ourselves refrain from adopting subsidies, quotas and 'discrimination' of all kinds, only to find that American exporters are able to override commercial competition by Government aid?"

These developments and the knowledge of huge preparation in Britain and the U.S.A. for export trade in the post-war period, which have caused grave anxiety among Indian manufacturers, do not appear to perturb the Indian Government. It was high time that the Government came forward with an exposition in broad outlines of their policy regarding industrial controls, and the question of protection and tariff. The Government have not thought fit to indicate to the public how industrial controls will operate in future and to what extent they are going to modify their present ill-conceived tariff and protection policy. Sir Ardeshir has stated that it has not yet been possible for Government to arrive at final decisions on the question of protection and tariffs, but that the Government are contemplating a liberalization of the existing protection policy and the elimination of some of the conditions attaching to the grant of protection to industries, as if by way of favour to Indian manufacturers. Further, there is no possibility that the existing controls imposed under the Defence of India Rules and detrimental, by their nature, to the growth of industries will cease to operate in the near future. We agree with the Planning Member that planning by its very nature implies control and regulations and that controls should remain throughout the period of planned development. But these must subserve a national policy. The people of Britain, the United States and the Dominions have submitted to controls first, because these subserve a national policy and secondly, because they have been taken into confidence with regard to their Government's control policy. The Government of this country have not done likewise. It is no wonder, therefore, that the response from leaders of Indian industry was meagre when Sir Ardeshir called upon them to book orders for capital goods in U. K. for which he was prepared to secure facilities.

Need for an Economic Organization

It is clear from the fore-going discussions that if the Government are really keen on giving a lead which the people can confidently follow, the supreme need of the present time is an announcement from the Government of their policy behind all these plannings, particularly of their industrial policy. It is true that the Government have appointed committees, consultants, experts, fact-finders, policy-advisers and others; but in the absence of a unified national policy, their efforts are destined to be 'a case of machinery without functions and of expenditure without result'.

In an all-round planned development for India, planning for economic reconstruction needs must stand out prominently. In economic reconstruction

again industries should occupy the foremost position, and nothing short of a separate Department of Industries can effectively deal with the problem of industrial development of India. In his booklet, Sir Visvesvaraya has pleaded for the creation of an economic organization which should comprise the following:—

(1) A separate Central Department of Industries with a full-time Member of Government in charge;

(2) An Economic Council to secure protection against foreign imports and dumping by adequate tariff regulation and other measures, to represent and protect the economic interests and wants of the people in the counsels of Government and to explore and recommend schemes of economic development generally;

(3) A grant of Rs. 8 crores per annum to be given, for five years to begin with, to carry out all forms of preliminary investigation necessary to stimulate economic advance, to grant subsidies and subventions to small industrialists, mechanics and shopkeepers, and generally to train them and encourage disciplined business life on modern lines in every district or geographical unit area;

(4) Provision of necessary staff and facilities for collecting statistics and other useful information and for pursuing an industrial and production drive in collaboration with the local business and labour population in each area.

The immediate functions of the organizations will be:—

(1) To work out a Five-year Plan for industries and to invest not less than Rs. 1,000 crores in the first five years;

(2) To take immediate steps to help businessmen to establish dozen retarded heavy industries, of which following is the list: automobile, aeroplane, Diesel engine, railway locomotives and power machinery generally, machine tools and machinery, iron and steel, heavy electrical industries, ship-building, special defense machinery (armaments and industrial plant), heavy chemicals such as sulphuric acid, chlorine, caustic soda, soda ash, nitric acid, etc., dyestuffs, rayon and plastics.

(3) To double the production from agriculture and industries in about 7 to 10 years.

(4) To expand the measures already being taken to industrialize rural areas with the help of leading citizens in every district.

(5) To establish an Institute of Higher Technology in some Central Capital City on the model of M. I. T.

Sir Visvesvaraya is strongly of opinion that economic planning for India will hardly be possible without such an organization comprising an Economic Council and a Department of Industries. The creation of the Department of Planning and Development, as can be easily seen, is no substitute for these bodies. Under the present dispensation industrial planning has been rendered difficult by the fact that 'Industries' still continues to be a portfolio of the Department of Industries and Civil Supplies and that the responsibility of developing industries is shared by the Provinces not always prepared to work in conjunctions, thanks to the Provincial Autonomy.

Sir Visvesvaraya's suggestion for the provision of necessary staff and facilities for collecting statistics is an invaluable one. The Government were always unwilling to maintain industrial statistics and discouraged initiation of steps to prepare one for obvious reasons. No planning is possible in the absence of reliable statistics. In fact, the Planning Member has now to depend on the voluntary supply of statistical information by the existing industries. The establishment of a central organization charged with the responsibility of collecting and maintaining up-to-date statistics in every field of human activity is, therefore, a *sine qua non*.

But the main question is: Can India have any workable national planning without a National Government? According to Sir Visvesvaraya, any such idea is as illusory, as it is absurd. So long as India is ruled as a Dependency by a Government responsible not to the people of this country, but to foreign vested interests, no effective and unified national planning is possible, far less its execution. A National Government formed out of the trusted representatives of the 400 million people, and nothing short of that, can alone undertake to plan for India's belated reconstruction.

ARTIFICIAL RADIOACTIVE BODIES IN PHYSIOLOGY AND MEDICINE

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(Continued from the last issue)

EXPERIMENTS WITH RADIOACTIVE PHOSPHORUS

By far the greatest amount of tracer work has been done with radioactive phosphorus (P^{32}). P^{32} has a very convenient half-life of 14·3 days, occurs very commonly in animal tissues and emits β-rays upto a maximum energy of 1·7 million electron volts. These electrons may be easily detected either with an electroscope or a Geiger Müller counter. P^{32} may be prepared by bombarding ordinary red phosphorus with deuterons. The phosphorus is then converted into a neutral solution of di-sodium phosphate which may be given to the experimental animal either by mouth or by injection. The animals (chicks, rats, mice, etc.) to whom radiophosphorus is given are killed at fixed intervals after the application and all organs and samples of other tissues are removed and

ashed. From a measurement of the radioactivity of the ash, bones, excreta etc., one can follow accurately the absorption, utilisation and excretion of phosphorus by the animal system.

These experiments show that the phosphorus in bones, muscles and fat is continually being added and replaced so that the equilibrium is dynamic and not static. Such dynamic exchange of phosphorus also takes place in the brain. Within an hour of application of labelled phosphorus lecithin containing P^{32} can be isolated from the brain of rats.

The greatest amount of radio-phosphorus is deposited in bones and muscles. When the activities per gm. weight of tissues are compared, bone has the highest activity and blood the least. Spleen, skeletal muscle, fat and liver come next to bone. Comparison of the activities on the 4th and the 60th day of application of labelled phosphorus, indicates that radio-phosphorus shifts mainly from muscles and intestine to bone and bone marrow.

The seat of the greatest production of phospholipides and nucleoproteins is the liver. The liver of normal mice is characterised by a high activity which reaches a maximum within a few hours of application of labelled P. At the height of its maximum activity 3% of administered P is present as phospholipid per gm. weight of liver. The activity of liver decreases rapidly after reaching the maximum, being only 1% at the end of two days.

A comparison of the specific activity of phospholipid phosphorus of plasma with that of the other organs shows that liver is the principal site for phosphorylation of plasma phospholipid. Normally appreciable amounts of radio-phospholipid appear in the plasma within 3 hours of a single injection of P^{32}. But if P^{32} is administered immediately after the removal of liver, no P^{32} appears in blood even 6 hours after application. In normal rats the activity of the plasma reaches a sharp maximum within 36 hours of application of P^{32}, when 0·5 – 1·0 per cent. of the administered dose may be recovered from plasma phospholipids. Compared with the plasma, the corpuscles take up phosphorus very slowly. The highest activity of the cells (50% of that of the plasma) appears only after 8 days in the case of man.

Compared to liver, kidney and intestines inactive tissues like muscles and brain show very slow but regular uptake of radioactive phosphorus. In the case of brain a progressive increase in the amount of radio-phospholipid can be followed even 9 days after the application of P^{32}. Once P has been deposited in these tissues, its loss is also very slow, 70% of the maximum activity is retained by the brain even after a month.

Egg laying increases the rate of turnover of phosphorus by blood, ovary and oviduct. Hevesy showed that most of the yolk phosphatide is derived from plasma but formed in liver. The same also applies to milk phosphatides.

Phosphorus metabolism in mice with different tumor transplants has been studied with great care. Four kinds of mouse tumors *viz.*, mamary carcinoma, lymphoma, lymphosarcoma and sarcoma 180, have been investigated. Phosphorus intake per gm. weight of tissues of mouse as a whole, is found to be the same for normal and lymphomatous animals. The activity per gm. of tumor tissues is found to be higher, the excess deposition of radio-phosphorus in the tumor being at the expense of that in bone and liver. The phospholipid turnover in the tumor tissues shows a great resemblance to that of live tissues like liver or kidney. In all such cases the amount of labelled phosphorus deposit rises quickly to a maximum within a few hours of application and then the activity diminishes rapidly. Per gm. weight, the activity of the liver is several times greater than that of any of these tumor tissues examined.

Blood counts of the chicken fed on diet containing P^{32} show a decrease in polymorphonuclear leucocytes without affecting lymphocytes. Since bone marrow produces the polymorphonuclears, a decrease in their number may be explained to be due to the action of selective irradiation from radioactive phosphorus deposited on the bones.

Selective accumulation of radio-phosphorus in nuclei of rapidly growing cells has encouraged its use in leukemia and allied diseases. Radio-phosphorus is applied by weekly intravenous injection and a radioactive level of the whole system is maintained at about 5 millicuries. Most encouraging results have been obtained with polycythemia vera and multiple myeloma. In leukemia, Hodgkin's disease and lymphosarcoma the response seems to be similar to that of X-rays. Experimenting with radioactive phosphorus and leukemic mice Lawrence and Scott have come to the conclusion that in the case of leukemic mice bones do not retain as much phosphorus as in normal ones. In other words, there is something wrong in phosphorus metabolism in leukemia.

Another interesting application of radiophosphorus has been in the study of insect metabolism. Selective accumulation of radioactive substances in different organs of the insect can be studied very conveniently with the auto-radiograph technique.

Radioactive Calcium and Strontium

Radioactive calcium (Ca^{45}, half-life 180 days) has been prepared by bombarding calcium with the deuteron beam from the cyclotron. The active portion is scraped off from the target, freed from contaminations of radioactive scandium and then finally obtained as carbonate after repeated precipitations as oxalate. Radioactive calcium, however, can only be

obtained in small amounts and emits very feeble beta rays. Pecher has shown that it is much more convenient to use radioactive strontium in the place of radioactive calcium in tracer experiments, as the chemical similarity of the two elements also corresponds with a similarity in their physiological metabolism. Radioactive strontium (Sr^{89}) has a convenient half-life of 55 days, can be prepared in relatively large amounts and emits beta rays of maximum energy 1·5 million electron volts.

Radioactive calcium and strontium lactate are injected intravenously to mice. At different periods after injection, the animals are killed and radioactivity of bones, soft tissues, uterus etc., measured. It is found that the uptake is 3 times as great when calcium is applied intravenously as that after oral administration. No significant differences appear when strontium is given either in chloride, lactate or gluconate form. 58% of the calcium and 33% of strontium are recovered from the bones 24 hours after intravenous injection. Activity of the soft tissues is found to be negligible. The uptake of calcium is greater than that of strontium, but the distribution of activity amongst different organs is almost identical. The following table due to Pecher indicates the percentage uptake of radioactive calcium, strontium and phosphorus by different organs, 24 hours after intravenous injection of radio-calcium lactate, radio-strontium lactate or sodium radio-phosphate.

TABLE II

Radio-element	Percentage of Dose per Gram Wet Weight					
	Bone	Muscle	Skin Hair	Dig. tract	Liver	Other viscera
Ca^{45}	22	·33	·20	·36	·12	·23
Sr^{89}	12	·17	·15	·23	·07	·13
P^{32}	5·2	1·4	·75	1·3	3·0	2·1

Autoradiograph technique has been largely used to study gross distribution of radioactive substances in plant and animal tissues. After the radioactive substances have been applied and absorbed by the tissues, a thin section is cut and placed on the photographic film. The beta-radiation from the radioactive substances affects the photographic plate, the intensity of which is proportional to the amount of radioactive substances concentrated there. The following photographs due to Hamilton, show the difference in distribution of absorbed radio-phosphorus and radio-strontium in rat tissues. It will be seen that while radio-strontium is mostly concentrated in bones, radio-phosphorus is also taken up by the soft tissues.

It has been observed that the activity of the bones increases during the healing of a fractured bone. The activity of radioactive calcium in the healing tibia of a rat is found to be 1·7% compared with 0·4% in the other.

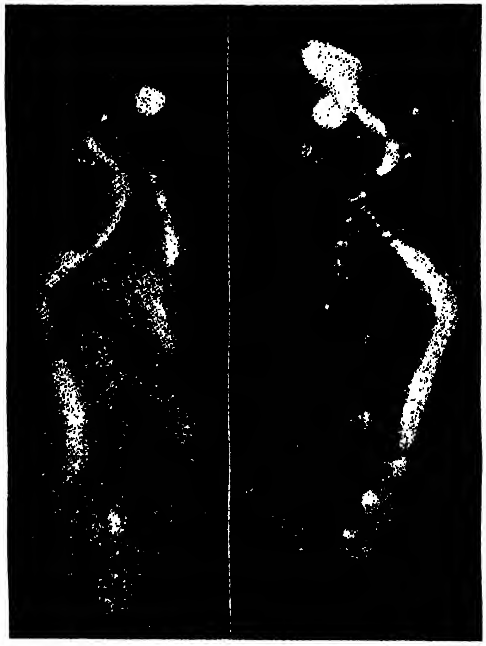

FIG. 7. Autoradiograph of rat tissues after absorption of radioactive phosphorus and radioactive strontium, showing characteristic differences in the mode of distribution of the two radio-elements.*

A large fraction of the calcium previously fixed on the bones of the mother, migrates to the foetus during the last days of pregnancy and also to milk during the lactation period. The specific activity of the bones of a new born mice is found to be about twice as great as the activity of the bones of the mother. If radio-strontium is given during the lactation period, a large part of the dose may be recovered from the offspring after two days. Pecher found that almost eight to ten per cent of the injected radio-strontium could be recovered from the milk of cows during the four days following the injection.

The selective fixation of radio-calcium and radio-strontium on growing bones including bone tumors, suggests important therapeutic applications. It remains to be seen whether these substances prove to be of importance in the treatment of osteogenic sarcoma, giant cell tumors, and metastatic bone tumors.

An interesting by-product in the preparation of radio-strontium is radio-yttrium (Y^{88}, half-life 87 days). This is produced in very large intensities

*Photographs by the courtesy of the Journal of Applied Physics.

when stable strontium (Sr^{88}, 82%) is bombarded with deuterons according to the following reaction

$$_{38}Sr^{88} + {}_1H^2 = {}_{39}Y^{88} + 2_0n^1$$

13 mgms radium-equivalent of yttrium are prepared per milliampere-hour of the deuteron beam. Radio-yttrium emits a large amount of gamma radiation (maximum energy 2 million electron volts), and may be used in the place of radium as gamma ray source and has also possibilities in radiography.

Radio-Iodine

Radio-iodine (I^{131}, half-life 8 days) has been used by Hamilton and Soley for studying iodine metabolism in normal subjects as well as in persons suffering from various thyroid disorders. The radio-iodine is prepared by bombarding 1-2 gms. of metallic tellurium with the deuteron beam. The bombarded tellurium is then dissolved in nitric acid and radio-iodine separated by distillation. The iodine may be administered orally as NaI dissolved in water.

The activity of the samples used in such experiments usually varies from 12-50 microcuries. The rate of accumulation of iodine by the thyroid is measured with the help of a Geiger Müller counter placed close against the gland. The accumulated radio-iodine emits gamma rays which are easily detected by the counter. This method has the great advantage over all the chemical methods in that the thyroid need not be removed, the measurements may be carried out *in situ* and the rate of accumulation of iodine followed from day to day. The radioactive method requires fewer subjects, is less time-consuming and can be applied to human patients. The excretion of iodine through urine and fæces can be investigated in the usual way by measuring the activity of these.

These experiments reveal that iodine accumulated by normal thyroid, reaches the maximum equilibrium value within two days of its application. This equilibrium value (4-5% of administered I) is maintained for several weeks afterwards. Non-toxic goitres with normal metabolic rates, show iodine uptake of the same nature but with a higher equilibrium value of 10-12%. In the case of thyrotoxicosis, the rate of iodine accumulation may be very high reaching a peak value of 12-30% of the administered iodine within 4 hours of the application. But the thyroid in such cases is unable to retain the accumulated iodine ; the amount of radio-iodine drops to 1/2 to 1/5 of the maximum value within 24 hours. In the case of hypothyroid children without goitre, the uptake of iodine by the thyroid is found to be vanishingly small (·05 per cent). In some of the cases investigated, the subjects subsequently underwent thyroidectomy and the amount of accumulated iodine was estimated by direct measurements. The two measurements agreed within 10%.

The experiments indicate that while radioactive iodine may be of value in the treatment of thyrotoxiosis, it is not likely to be of use in the malignant diseases of the thyroid, as cancerous thyroids do not seem to possess the ability to accumulate iodine to a great extent.

A point of great interest in this connection is the discovery of the missing element 85 which is a homologue of iodine and is named eka-iodine. It is found to be radioactive with half-life of 7·5 hours and emit α-rays. The element 85 is selectively absorbed by the thyroid in the same way as it absorbs iodine but to a much lesser extent. However, although the physiological properties of element 85 and iodine are similar, the former emits α-rays of average energy of 4 million electron volts while radio-iodine emits β-rays and γ-rays. The ionizing action of α-rays is confined to regions very close to the source and that of γ and β-rays is spread over comparatively larger volumes. The element eka-iodine is therefore likely to be of great value in diseases of the thyroid.

Radioactive Sodium, Potassium, Chlorine, Bromine

Radioactive sodium (Na^{24}, half-life 14·8 hours) may be obtained very conveniently by bombarding common salt with deuterons. Both radio-sodium and radio-chlorine are produced, but the radioactivity of chlorine dies out so rapidly (half-life 33 min.) that after about 24 hours we are left with labelled sodium chloride, of which only the sodium atom is radioactive. The radioactive salt may then be injected or applied orally either in an aqueous solution or in a capsule.

In one experiment a person held a Geiger counter by the hand which was protected by Pb on all sides, so that radiations from the radioactive salt present in the body could not affect the Geiger counter. The person drank a solution of the radioactive salt in water. Na*Cl, K*Cl, LiCl*, KBr*, and NaI* were used in similar experiments. In every case the counter began to respond within 5 minutes after the solution was drunk, showing that marked atoms are absorbed in the blood stream and reach the fingers within such a short time. The activity of the fingers increases steadily and reaches the maximum equilibrium value within 3 hours. There is not much difference in the rates of absorption of radioactive sodium, chlorine, bromine or iodine, only potassium is found to be absorbed rather slowly.

If radioactive sodium is applied by injection, sodium is found to reach a constant level in blood within 15 to 20 minutes of its application. Subsequent fate of sodium within the human system can

be investigated by measuring the activity of samples of blood, urine, spinal fluids, sweat, etc. with the help of a Geiger counter. A very small quantity of the radioactive sample (about ½ millicurie) is sufficient for such experiments. Very little sodium is found to enter the blood corpuscles although there is plenty in the spinal fluid and blood plasma.

Radioactive sodium and potassium ions have been greatly used in experiments on cell permeability. After intravenous injection of Na^{24} and K^{42} to rats it is found that the radioactive isotopes disappear quickly from the plasma. Subsequent analysis of the tissues enables one to determine the relative permeability of the various tissues. Liver, gastro-intestinal tract, kidney and heart show a rapid rise and subsequent fall in activity with peaks delayed by different amounts. Skin, muscles, tests, brain etc. show on the other hand a very slow rate of uptake compared to the former tissues.

Radioactive Iron

Radioactive iron (Fe^{59}, half-life 47 days) may be produced by bombarding normal iron (Fe^{58}) with the deuteron beam. Radio-iron decays with a half life of 47 days emitting β and γ-rays as shown in table I.

Radio-iron has been extensively used to investigate the rate of synthesis of hemoglobin in normal animals as well as in those animals which have been made anemic by repeated bleeding and feeding on a low-iron diet. Iron may be introduced orally in the form of ferric salts. Blood samples are collected at various intervals after the application of radioactive iron and hemoglobin separated. A measurement of its radioactivity indicates the proportion of iron that has been synthesized into hemoglobin during the time of the experiment. The experimental animals may also be sacrified at various intervals after the application of radio-iron and the activities of the tissues measured with a Geiger counter.

It is found that the site of the greatest absorption of iron is the small intestine and that the rate of absorption is fast in anemia and slow under normal condition when the reserve of iron is ample. When the body tissues have been previously depleted of the iron reserve, by continuing anemia for three or four weeks, the uptake of radio-iron may be as great as fifty times as in normal animals. Plasma is the means of transport of radioactive iron. It is found that the absorbed radio-iron is first present in the plasma and then fixed in the hemoglobin of the red cells. Radioactive iron may appear in the red cells within an hour of feeding iron contained diet; the peak of absorption in anemic dogs occurs within 4-8 hours after feeding and the absorption is practically complete within 18 hours. The muscle tissues appear to be the storage depot for iron, 25 per cent. of the administered iron being accumulated in the muscle tissues of anemic dogs and 14 per cent. in the blood. The rates of elimination of iron in normal and anemic dogs are however not much different, this seems to indicate that the iron level is controlled not by its elimination as was previously believed but by its absorption.

The amount of iron secreted in the milk of cows fed on an iron-containing diet may also be measured by the same technique. It is found that a cow giving four litres of milk per day secretes on the average about 0·5% of the administered oral dose of 10 gms. of iron. This corresponds to about 12·5 mgms. of iron per litre of milk which is quite sufficient for a growing child consuming a litre of milk per day.

Radioactive Sulphur and Arsenic

Radioactive Sulphur (S^{35}, half-life 87 days) emits beta rays of very low energies (maximum energy about $\frac{1}{10}$ million electron volts). Special types of beta-ray counters are needed for their detection.

Most proteins contain one or more amino acids containing sulphur. Radio-sulphur has been used in the study of protein metabolism. After feeding methionine containing radioactive sulphur to hens, sulphur^{35} is detected in the egg white on the second day, its concentration reaches the maximum value on the fourth day. Similarly after administration of methionine containing radio-sulphur to rats, it is possible to isolate cystine containing the radioactive isotope from the hair and tissues of experimental animals.

Vitamin B_1, synthesised from radio-sulphur has been injected intramuscularly to human subjects and its storage, excretion and utilisation studied. Presence of radioactive sulphur in inorganic form in the urine, indicates that the injected thyamin is rapidly destroyed in the human system (10% of the injected amount destroyed every 24 hours). When a person is on normal diet 61% of the injected thyamin can be recovered from the urine, 11% from the feces during a period of 3 days following injection.

Radioactive arsenic ($_{33}As^{74}$, half-life 16 days) may be prepared by subjecting stable arsenic ($_{33}As^{75}$, 100%) to neutron bombardment.

Potassium arsenite containing radioactive arsenic As^{74} has been injected in 4 daily doses to albino rats, guinea pigs and rabbits and the arsenic content of liver, kidney, spleen, brain etc. determined. During life, daily blood arsenic determinations are also done. The highest concentration of arsenic in the case of rats seems to be in blood, the measurable amount being confined to red corpuscles. Maximum concentration occurs 24-48 hours after last injection and at this time the total As in blood amounts to 50-60% of the amount injected. Spleen shows the highest and kidney the lowest concentration of arsenic.

Radioactive arsenic has also been injected to

human subjects at the rate of 1·5 mgm. per day for 4 days. It is found that about 50% of the injected daily dose is daily eliminated, 99% of the elimination is *via* kidney. However no arsenic could be demonstrated in the blood either in normal or leukemic subjects.

Investigations in Plant Physiology

The earliest experiments with the radioactive bodies as tracers were carried out by Hevesy (1923) on plants using ThB and RaD to trace the fate of lead in plants. Since the discovery of artificial radioactive bodies, radioactive isotopes of many common elements have been used as tracers in place of natural radioactive substances.

In these investigations intact plants are kept rooted in nutrient solutions containing minute doses of radioactive salts (*e.g.*, radioactive phosphorus may be applied as 0·5 per cent. solution of KH_2PO_4). The upward and lateral movement of the salts can then be studied by examining sections of wood, bark etc., either with a Geiger counter or an electroscope. Such experiments indicate that wood is the vehicle of rapid upward movement of both anions and cations assimilated by the roots and that the ions move radially from wood to bark at a comparatively slow speed. It is also observed that there is a downward motion of the assimilated ions.

The autoradiograph technique described above has also been used in these investigations with a great deal of success. The following figure shows the distribution of radio-phosphorus in the leaves of a tomato plant removed 36 hours after the application of radio-phosphate to the nutrient solution.

These radiographs show that the green fruits and particularly the seeds of the green fruits concentrate phosphorus to a marked extent.

The exchange of ions by the living protoplasm has also been invested with the help of radioactive tracer ions of $\overset{+}{K}$, $\overset{+}{Na}$, $\overset{+}{Rb}$, $\overset{-}{Br}$, and $\overset{=}{HPO_4}$. It is observed that these ions enter the cells by interchange with other similar ions (Na with Na, K, hydrogen or organic bases) resulting from metabolic processes. By temporarily associating with the radicals of the protoplasmic protein molecules, the elements travel from one molecule to another until they reach the vacuole. The equilibrium thus becomes a dynamic phenomenon.

A great deal of work on photosynthesis has been carried out with the short-lived radioactive carbon isotope C^{11}. Carbon has a half-life of only 20·5 minutes and emits positrons of about one million electron volts maximum energy. Carbon has also another radioactive isotope of very long life (C^{14}, half-life 1000 years) which is produced by the bombardment of nitrogen by neutrons.

Fig. 8. Autoradiograph of the leaves of a tomato plant grown in a nutrient solution containing radioactive phosphorus.

In the experiments of Ruben and Kamen the gas from the target chamber is passed over heated cupric oxide and carbon dioxide containing radioactive carbon is collected in a U-tube immersed in liquid air. For experiments on photosynthesis unicellular green alga chlorella is exposed to $\dot{C}O_2$, the system is then evacuated and an aliquot of the algal suspension removed and tested for reduced carbon.

Ruben and his coworkers find that the alga and green plants are definitely able to fix carbon dioxide in the complete absence of light. Diffusion experiments indicate that the first stage in the fixation of CO_2 is its reduction to a carboxyl acid group and that this is a reversible process. The uptake is very rapid at first but at the end of an hour, equilibrium is established. The dark reduction process is believed to be of the following type

$$RH + \dot{C}O_2 \rightleftharpoons R\dot{C}OOH$$

Here R is a large molecule. In the absence of light no further reduction probably takes place as all radioactive carbon appear to be in the carboxyl group.

The reduction of CO_2 in the presence of light seems to be non-reversible, the rate of uptake of radioactive carbon being the same throughout the experiment. Only a small fraction of labelled carbon

is found in the carboxyl radical. The light reduction of carbon dioxide is probably a process of the following type

$$R\dot{C}OOH + H_2O + h\nu \longrightarrow R\dot{C}H_2OH + O_2$$

$R\dot{C}H_2OH$ molecule may then take up further CO_2. This mechanism of photosynthesis is at variance with the classical ideas. Further these experiments reveal that non-photosynthetic organisms *e.g.*, yeast cell, B.Coli, rat liver cells etc., also have the capacity to reduce carbon dioxide.

The radioactive nitrogen (N^{13}, half-life 10 min.) has been used to investigate the problem of nitrogen fixation by plants. Charcoal is bombarded by the deuterons in a gas-tight chamber and the gas from the chamber is passed over heated cupric oxide into a desiccator containing barely plants, the roots of which have been previously removed in order to exclude bacteria. For control, other barley plants killed by boiling water are kept side by side with the living. These experiments indicate definitely that nitrogen can also be fixed by the barley plants. The experiments are of great interest as there is a good deal of controversy regarding the fixation of nitrogen by the non-leguminous plants.

In this article only a very brief account is given of the important results obtained with this fascinating technique of radioactive tracer analysis. This new method of approach to complicated biological problems seems to be the most promising since the discovery of the microscope. The immense possibilities of this new method have been long realised in America, the birth place of the cyclotron. Many philanthropic bodies and research foundations have made special endowments to universities and laboratories for carrying on specially work of this nature. Mention may be made of Rockefeller Foundation, Carnegie Institute, National Research Council, Chemical Foundation, John and Mary Markle Foundation, Jane Coffin Childs Memorial Foundation etc. among many others. All experiments described above have been carried out with financial assistance from one or the other of these research foundations.

In this country we had the good fortune to start this important line of investigations with financial grants from two of the leading industrial houses of India *viz.*, the Tatas and the Birlas. Without their generous help this work could not have been undertaken. We hope that in our work in future we shall continue to receive the same sympathy and assistance from the public as we had in the past.*

* My thanks are due to Prof. M. N. Saha, F.R.S., and Dr B. D. Nag Choudhury for many useful criticisms of this report.

FERTILIZER INDUSTRY IN INDIA

INDIA is a country where 80 per cent of the population are dependent directly or indirectly on agriculture. Yet she is not self-sufficient as regards foodstuff even on a very low standard of diet. Before the war, we used to import about 2 million tons of rice from Burma, Indo-China and also a large quantity of wheat from Australia. Partial failure of rice-crops and stoppage of supply from Burma led to disastrous consequences in Bengal last year. The Government of India and the public are therefore anxious that production of cereals should be so increased in the country as to ensure food to all not only on the existing low standard of diet but on a somewhat higher level considered adequate by experts on nutrition. The Bombay Plan of economic reconstruction aims at increasing agricultural income by 130 per cent. Government's present plan is, however, far less ambitious. As envisaged in the recent report of Dr Burns, a 30 per cent increase in production is urgent, and there is no reason why it should not be achieved even in war time as a result of the grow-more-food campaign.

Need for Synthetic Fertilizers in India

As an illustrative example, we shall take the most important food crop—rice. We grow on an average 28 million tons of rice in an area of 76 million acres, about 750 lbs. per acre. This is the most depressing fact about our agriculture. In U.S.A. the average production is 1500 lbs. and in Japan 2300 lbs. per acre. This is mainly due to lack of water and manure. The agricultural experts are convinced that, given ample water and ample manure, rice yields can be forced very much higher. There are indeed some well-managed farms in Coorg which is so near to us, where a yield of 3000 lbs. per acre is not uncommon. The statistical average of all manurial experiments carried out all over India between 1933-1939 indicates that 80 lbs. of ammonium sulphate applied per acre to land containing sufficient humus increases the production of paddy by 280 lbs. which is equivalent to 210 lbs. of rice, *i.e.* roughly 30 per cent increase in present production. If ammonium sulphate is given along with super phosphate, the

yield is generally higher. At pre-war prices of ammonium sulphate, paddy and straw, the increased net profit per acre was Rs. 7/- (ammonium sulphate to cultivator Rs. 200/-, paddy Rs. 2-4 for 80 lbs., and straw 4 annas for 80 lbs.). If the price of ammonium sulphate to cultivator remains the same, Rs. 200/-, the increased profit per acre at present prices will be far greater—about Rs. 28/-. 76 million acres of rice lands in India will require annually about 2·55 million tons of ammonium sulphate in order that we may reach our target of production which is 36 million tons of rice. Government of India hopes to establish factories under State auspices which will produce 350,000 tons of ammonium sulphate by June 1946. It is also hoped that once this Government enterprise is successful, private enterprise will be soon forthcoming to produce the balance required, *i.e.*, 2·2 million tons of ammonium sulphate.

In 1938-39, India imported 76,000 tons of ammonium sulphate from Great Britain, the cost at port being Rs. 110/- per ton. There is something thoroughly rotten in a distribution system which exacted from the cultivator Rs. 200/- per ton as retail price. With this experience, one cannot be too alert about consumer's interest. There is no reason why the price to the consumer should exceed the factory price or the price at port by more than 10 per cent plus the cost of additional transport.

In 1938-39, the internal production of ammonium sulphate was only 25,000 tons. This was obtained from the coal distillation industry of Behar and Bengal as a by-product. On distillation of coal to form coke, nitrogen of the coal is released in the form of ammonia, which is removed from the coal-gas by scrubbing with sulphuric acid. Those interested in the details of the process developed in India may read the interesting memoir of Wilson Haig, General Manager of the Bararee Coke Oven Co.

Fertilizer Industry in Mysore

It is to the Government of Mysore that we owe the establishment of the first synthetic ammonium sulphate factory in India. The factory in Mysore at Belagula started producing 5 tons of ammonia per day since 1941. The sulphuric acid plant can produce 27 tons of sulphuric acid per day ; the total capacity for production per year is 7000 tons. We shall only outline the broad features of the process :— The manufacture of ammonium sulphate consists firstly of the manufacture of ammonia by interaction of nitrogen with hydrogen and then the conversion of ammonia into ammonium sulphate. In Mysore (Belagula), the hydrogen is obtained by electrolysis of caustic soda solution using nickel plated anodes. For 1 ton of ammonia we require 2250 cu. metre of hydrogen gas. We also require 750 cu. metre of nitrogen gas, which in Belagula is obtained by burning 380 cu. metre of hydrogen in 940 cu. metre of air. We thus require 2630 cu. metre of hydrogen and 940 cu. metre of air for the synthesis of 1 ton of ammonia. Taking into consideration losses and impurity of oxygen in hydrogen, we require 2700 cu. m. which will consume 15,200 kWh D.C. power. The mixture of nitrogen and hydrogen is compressed to 300 atoms. perfectly dried and freed from impurities and passed through converters of special steel containing more than 2 per cent chromium, which contained the catalyst. The catalyst is obtained by fusing from oxide and then impregnating it with promoters like Al_2O_3 and K_2O. The cooled mass is broken to requisite grain size, and porous but rugged structure is obtained by reducing in a current of hydrogen at about 500°C. This catalyst at a space velocity of 40,000 cubic feet per hour per cubic feet of catalyst will give about 16 per cent conversion into ammonia. The converter is so designed that under these conditions, the heat of reaction maintains the catalyst at about 480°C. The ammonia is removed by refrigeration which in general commercial practice amounts to 80 per cent of the ammonia present. The uncombined gases containing the residual ammonia is recycled. Auxiliary power necessary for compression and other purposes amounts to 1300 kWh per ton of ammonia. The cost of production of ammonia per ton may be estimated thus :—

16,500 kWh at ¼ anna	...	Rs. 260
Cost of repair and maintenance	,,	10
Salaries and wages	... ,,	5
	Total	Rs. 275 per ton

If kWh costs 1/10th of an anna, the cost becomes Rs. 18/- per ton.

This is exclusive of depreciation charges which are very heavy and interest on capital invested. If A.C. power in bulk is already available in factory site, as was the case in Mysore (Belagula) the capital cost per ton year of ammonia would be Rs. 500/-. Taking depreciation at 15 per cent and interest at 5 per cent, the running cost of production has to be increased by Rs. 100/- per ton to give the fair selling price of ammonia ex-factory.

In Mysore (Belagula) sulphuric acid is manufactured by burning sulphur vapour with air to SO_2 and passing SO_2 with excess of air over V_2O_5 catalyst in a converter which is maintained by the heat of reaction at about 500°. There is complete conversion into SO_3 which is dissolved in 98·3 per cent H_2SO_4 to give fuming sulphuric acid. This is continually diluted with requisite water to maintain constant the strength of sulphuric acid. The advantage of the process is that it is practically continuous and automatic and requires only equipment made of iron.

The capital cost of a plant is Rs. 50 per ton year, and the fair selling price of sulphuric acid at factory should not be more than 40 per cent of the cost of pure sulphur and Rs. 20/-. If sulphur is purchased at Rs. 100/-, sulphuric acid should sell at Rs. 60 ; if bought at Rs. 200/-, the acid should sell at Rs. 100/-.

Ammonium sulphate is obtained in the crystalline solid state by combination of ammonia with sulphuric acid in the ratio approximately of 1 : 3 by weight. The fair selling price of ammonium sulphate per ton should be ¼th that of ammonia + ¾ that of sulphuric acid + Rs. 5 as processing cost. Taking the higher values Rs. 375/- and Rs. 100/-, the selling price of ammonium sulphate should be Rs. 175/- per ton. Taking the lower values 218 and 60, the selling price ex-factory is Rs. 105/- per ton.

Manufacture of Ammonium Sulphate in Travancore

We owe to the Government of Travancore the next advance in our synthetic fertilizer industry. The State is densely populated and only produces 40 per cent of its food requirements. It is the deliberate policy of the State to increase food-production to at least 60 per cent of its requirements. The State possesses several advantages. There are tropical monsoon hard wood forests which can be regenerated in a cycle of 30 years, and it is estimated that 100 tons of charcoal containing 75 per cent fixed carbon could for ages be delivered at a factory site (near the Alwaye Railway Station) at a cost not exceeding Rs. 20/- per ton. There are extensive deposits of gypsum of 85 per cent purity in Trichinopoly which can be carried by rail (to Alwaye) and delivered at factory at a cost not exceeding Rs. 15/- per ton. It is not at all difficult to wash this gypsum off its clayey matter and raise the purity to 95 per cent. Electric power in bulk can be had from the Pallivasan Hydro-electric Station at 1/5th an anna per unit. Alwaye is within 25 miles by rail of the magnificient Cochin harbour and also has waterways which are extensively used by cheap country craft transport.

The method of making hydrogen by the action of carbon on steam is far more complicated than simple electrolytic preparation. The standard method consists of two processes:—

(1) Blowing air over a bed of coke and raising the temperature to 1200° by the reaction

$$(C+O_2 \longrightarrow CO_2+96 \text{ Cal.})$$

Then passing steam over hot coke and getting water gas, $CO+H_2$, according to reaction

$$(C+H_2O \longrightarrow CO+H_2-19 \text{ Cal.})$$

Steam is stopped as soon as the temperature of coke bed falls to 900° and then air blown in and the cycle repeated.

(2) The second stage consists in converting carbon monoxide of water gas by interaction with steam to carbon dioxide and hydrogen

$$(CO+H_2O \longrightarrow CO_2+H_2+8 \text{ Cal.})$$

This is done in presence of catalyst at temperature of 500°.

The total reaction is therefore

$$(C+2H_2O \longrightarrow CO_2+2H_2.)$$

In actual practice, water gas is mixed in suitable proportions 3 : 2 with producer gas which is obtained by passing moist air over heated coke and has the composition N_2 = 51 per cent., CO = 26 per cent, H_2 = 14 per cent and CO_2 = 9 per cent. The mixed gases having the average composition 23 per cent N_2, 70 per cent $CO+H_2$ and rest CO_2, hydrocarbons etc. are passed through water gas converter chamber which gives a gas mixture containing H_2 and N_2 in the ratio of 3 : 1 and considerable quantity of CO_2. This CO_2 is removed by high pressure scrubbing with water. We shall soon see that this CO_2 recovery is essential in the manufacture of ammonium sulphate with the aid of gypsum.

In the process that will be adopted in Travancore, this separate preparation of water gas and producer gas and then mixing them together in the requisite proportion will be avoided. The only reason why water-gas is made by a discontinuous alternate blow and run process is that ordinary metallic converters cannot stand the extremely corrosive action of steam and CO at 1100°, and hence furnaces lined with fire bricks had to be used which cannot be economically heated by external firing. The American engineers now claim to have developed suitable alloys which can stand this severe corrosive action ; and it is intended to gasify with requisite steam and air 57 tons of charcoal every day in such alloy tubes externally heated with powdered charcoal. Standard methods will be adopted for the purification of N_2 and H_2 mixture before they enter the catalyst chamber at a pressure of 300 atmos. and 475°C.

The ammonia converter at Travancore will differ from that at Belagula in that its capacity will be 8 times larger and that it will not be forged from a single alloy steel cylinder. It will have a laminated structure with several concentric cylindrical forgings pressed one over another to give it the requisite strength. The subsequent stages in the manufacture of ammonia is the same as that at Belagula.

There will be a marked difference, however, in the manufacture of ammonium sulphate. Instead of allowing ammonia to react with sulphuric acid, a mixture of ammonia and carbon dioxide in equivalent proportions will be passed through a suspension of very finely powdered gypsum in water.

$$2NH_3+CO_2+CaSO_4+H_2O \longrightarrow CaCO_3+(NH_4)_2SO_4$$

In this process, the conversion is complete and a solution containing 35 per cent by weight of ammonium sulphate can be obtained. It is interesting to note that CO_2 obtained in the water gas conversion, if recovered, is sufficient for carrying out this reaction. Hence the gypsum process is always associated with the manufacture of hydrogen from water gas. If, as is anticipated, $CaSO_4$ of 95 per cent purity is used for this process, the calcium carbonate sludge can be used for the manufacture of cement in an associated cement factory. In the Travancore factory, the sulphate making plant will consist of the following units:—One carbon dioxide recovery unit, one ammonia vaporising unit; one rotary reaction unit, filters, evaporators, crystallizers, gypsum grinding equipment and bagging plant.

The factory will have to be supplied with 5500 KW of electric power at a continuous load.

It has been estimated that the capital cost for this factory which will produce 40 tons of ammonia per day and hence 160 tons of ammonium sulphate will cost 1·7 crores of rupees, *i.e.*, Rs. 300/- approximately per ton of ammonium sulphate produced in a year. This is rather on the high side, as the prewar cost was of the order of Rs. 200/- per ton year. It is difficult to forecast the economics of the process. The Imperial Chemical Industries for their 250,000 ton plant at Billingham obtain coke at Rs. 25/- per ton and gypsum at about the same price. On this basis they could land ammonium sulphate at an Indian port at Rs. 110/- per ton. It is probable that the fair selling price of ammonium sulphate ex-factory (at Alwaye) will be about Rs. 90—100 per ton.

Technical Mission on Fertilizers

The Government of India have invited a Committee of experts to come from England and advise them on a site or sites suitable for putting up ammonium sulphate plants which will produce in the aggregate 300,000 tons per year, and also recommend the most economical process for adoption in British India. The Mission came to Bangalore sometime ago. As far as could be judged, they would recommend practically a duplication of the Billingham plant in the coal fields of Behar and Bengal so far as the production of ammonia is concerned. Whether this ammonia should be converted into ammonium sulphate by sulphuric acid or by gypsum is not yet settled. The extensive gypsum deposits of India are in Rajputana and are at a distance of 1300 miles from the coal fields. It may be cheaper to manufacture sulphuric acid from imported sulphur pyrites and use it for making ammonium sulphate.

Some of the Indian technologists have urged the Mission not to use coke for making hydrogen but to use cheap non-coking second class coals, in view of the imperative need of conserving our slender resources of coking coal for metallurgical purposes. Pointed attention has been drawn to the remarkably efficient processes that have been developed in Germany for making water gas from lignite which have brought down by 33 per cent the cost of production of hydrogen. It has also been urged that if American engineers could use charcoal containing 30 per cent volatile matter for making water-gas in Travancore, there should be no difficulty worth mentioning, in using cheap non-coking coal of Bengal and Behar for the same purpose. The plant in the coal fields will have one great advantage; coal can be had there at Rs. 4—5 a ton as against Rs. 20/- per ton of charcoal in South India. But this advantage may be counterbalanced by costlier labour and transport charges to consumers' centres.

Ammonium Nitrate as Fertilizer

Ammonia is a key industry as nitric acid is now manufactured exclusively by the oxidation of ammonia. Nitric acid is the basic chemical for all modern explosives, and its manufacture has increased enormously during the last five years. The possibility of keeping these nitric acid plants active in peace time is engaging the serious attention of chemical technologists in every country. Nitric acid can be made to combine with ammonia to give the solid salt of ammonium nitrate. So far as providing food to plants is concerned, nitrogen fixed as ammonium nitrate has the same property as that fixed as ammonium sulphate. The use of ammonium nitrate in India will have the additional advantage that the ammonia industry will be absolutely self-contained, independent of any import of gypsum or sulphur to the factory which will in most cases involve long haulage. But there are difficulties in its use as fertilizer; firstly, it is hygroscopic, it absorbs moisture from the air, forms solid lumps which may end in explosion if the cultivator tries to powder it. Secondly, it is said that it is easily leached away from lands subjected to heavy flooding. If these two defects can be removed ammonium nitrate will be the ideal nitrogen fertilizer for India and will be much cheaper for the same fixed nitrogen content than the ammonium sulphate.

Phosphatic Fertilizers

The emphasis on nitrogen fertilizer in India has almost made us unremindful of another important fertilizer—the phosphatic fertilizer. In 1939, the world's consumption of phosphatic fertilizer containing about 20% citric acid soluble phosphates was about 18 million tons which is double the production of ammonium sulphate. The consumption in India

was, however, meagre of the order of 12,000 tons. This industry will rapidly expand in India as the cultivator becomes more and more fertilizer conscious. There are phosphate deposits in India—at two centres, the phosphatic nodules in Trichy, and the phosphatic rock in Singbhum, Behar. The standard practice is to convert the insoluble phosphate by treatment with sulphuric acid to form superphosphate. The large production cost of sulphuric acid in India from imported sulphur has stood in the way of the development of the industry. It has been found, however, that such phosphate rocks can be solubilized by fusion with silica, feldspar, magnesium carbonate, etc. The process is practically the same that takes place in a rotary cement kiln. In the Chemical Department of the Indian Institute of Science, Bangalore a process has been worked out using Trichy phosphate as the starting material. The ore which contains about 52% calcium phosphate is treated first for removal of the incrustation of calcium carbonate, and a material containing 72% calcium phosphate is obtained thereby. This is then crushed to fine powder mixed with suitable fluxing agents and fed into a rotary kiln fired with an oil burner and maintained at a temperature of 1350°C. The fused mass slowly flows down the rotary convertor and on sudden cooling gives a feasable material which contains but 16 to 18% citric acid soluble phosphate. It has been estimated that such phosphatic fertilizer can be sold in India at Rs. 50/- per ton which is much cheaper than superphosphate manufactured with the aid of sulphuric acid. Extensive field trials are now being made with this material at the pilot plant of the Indian Institute of Science, Bangalore, and in the Madras Government Agricultural Farm at Coimbatore.

It is hoped that large scale production of this fertilizer will also begin at an early date. The importance of technological studies on problems of synthetic fertilizers industry in India cannot be over emphasized, and in any future plan of economic reconstruction of India, this industry will be considered as a No. 1 key industry.

J. C. G.

EFFECT OF THE FOOD CRISIS OF 1943 ON THE RURAL POPULATION OF NOAKHALI, BENGAL

RAMKRISHNA MUKHERJEA, CALCUTTA

(Continued from the last issue)

The character of the population thus affected by the food crisis is best represented by their source of livelihood which was the most important factor in enabling them to avert or to succumb to the crisis. Table 8 which records the sources of livelihood of the family units in December 1942, before the food crisis, and in December 1943, after they had borne the main brunt of it, indicates that for all the three classes concerned "agriculture and labour" and "labour" alone were the most important forms before the food crisis. The next group of importance was the combination of "agriculture

TABLE 8. Showing the sources of livelihood of the family units in December, 1942, before the food crisis, and in December, 1943, after the main brunt of it.

Source of livelihood	Class I (N—85)			Class II (N—105)			Class III (N—28)		
	Dec' 42	Dec. 48	Change form (1) to (2)	Dec. '42	Dec' '48	Change from Col (4) to (5)	Dec' '42	Dec. '43	Change from Col (7) to (1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agriculture	7	3	— 4	5	2	— 3	8	7	— 1
Labour	22	14	— 8	29	25	4	5	6	+ 1
Domestic service	5	7	+ 2	...	1	+ 1	...	...	...
Industry	6	3	— 8	6	7	+ 1	...	...	...
Trade	2	2	...	1	2	+ 1	2	2	...
Profession & Liberal arts ...	2	...	— 2	2	4	+ 2	...	...	...
Agriculture and labour	17	10	— 7	38	10	— 23	8	5	— 3
Agriculture and any (except labour)	13	8	— 10	9	5	— 4	4	5	+ 1
Labour and any (except agriculture)	5	1	— 4	...	1	+ 1	...	...	...
Any other occupation	4	11	+ 7	8	6	+ 8	1	1	...
Unproductive	2	31	+ 29	17	42	+ 25	...	2	+ 2

with any other occupation except labour". The other occupations—agriculture, industry, trade, etc., are of less importance except in class III where agriculture is next in importance to "agriculture and labour". It shows that, as in practically all over rural Bengal, the life of these people is based on agrarian economy.

But only in a few cases these families depend solely on 'agriculture' and usually combine it with other forms, mostly 'labour'. This is because these people have not got sufficient holding (as seen in Table 2(B), 43, 50, and 18 family units, having only 21·82, 16·95, and 8·42 acres of cultivable land between them, that is, about 0·51, 0·34, and 0·47 acres per family on the rough average) to provide their families for the whole year round and so they are bound to depend on earnings by other occupations. In most cases this is done by working on the big holdings of cultivable land of the better off persons who need hired labour.

So we can understand why these people were so much affected by the food crisis. In 1943 the prices of food stuffs, specially of rice, began to soar up at a tremendous rate while these people could neither be provided from their small holdings nor could they manage to buy the necessities from their meagre income. The result was that those who had some assets began to sell them and those who had not such things or had lost them already either starved and faced the natural consequence of death or became sick or invalid or took to begging and depending on charity to maintain their physical existence any how. Those who lost their property to avert the natural consequence could not thereby manage to escape it wholly. Many of them sold their holdings and as the result had to give up 'agriculture' (cultivating their own land) and take to other occupations losing even the little production of grains they would get otherwise. This is clearly brought out in the tables 8 and 9. The former table shows that 57, 64, and 15 per cents of the family units who practised 'agriculture' as one of their occupations have given it up. 36 and 14 per cents of the family units belonging to classes I and II who depended on 'Labour' as their source of livelihood have given it up, and the number of unproductive families has increased to staggering heights.

Table 9 which gives a detailed analysis of the unproductive families in December, 1943 shows that only a few families are traditionally unproductive, that is, they were unproductive even in December, 1942. About them also, it may be mentioned here, further investigation might show that even these have taken to this as the source of living not long ago and that this is the result of the gradual deterioration of the rural economy of Bengal which has been tremendously accelerated by the food crisis of 1943. The table points out that the rest have been forced to depend on charity as the result of the food crisis. It shows that 37 and 19 per cents of the earners belonging to the unproductive families of class I and II respectively were compelled to leave the villages in search of service as the result of the food crisis, leaving behind their family members to depend totally on charity. This means that 13 and 7 per cents of the total number of earners of the classes I and II respectively do not belong to the village economy any more. Due to the crisis 40, 30, and 100 per cent of the unproductive earners, that is 10, 11 and 6 per cents of the total earners are at present invalid through prolonged starvation and disease. That the diseases which have invalided them are mainly the result of the food crisis is proved by the fact that out of 20 persons invalided 14 are suffering from fever (malaria in most cases, the after effect of low vitality produced by prolonged starvation), 3 from dropsy, the direct effect of prolonged starvation, and 3 from other cases. Over and above this 17 and 12 per cents

TABLE 9. Showing the number of unproductive families and earners, and the cause of being unproductive in December 1943.

Unproductive causes / Earner	Unproductive families Class I (N—85)	Class II (N—105)	Class III (N—28)	Unproductive earners Class I (N—93)	Class II (N—116)	Class III (N—31)
Traditionally unproductive	2	17	...	2	17	...
Dead within Dec., '42- Nov., '43	6	5	...	6	5	...
Invalid from Starvation	1	7	1	1	7	1
" " Disease	9	6	1	13	6	1
Emigrant (whereabouts known)	11	3	...	11	4	...
" and Untraced	2	4	...	2	4	...
Total	31	42	2	35	43	2

of classes I and II, that is, 6 and 4 per cents of the total earners in these two classes have died and so the only way left to their families for survival is to depend on charity. That this high mortality is mainly due to the food crisis will be shown in a following page. On the whole, the table points out that as a result of the food crisis in the classes I and II, 6 and 4 per cents of the total number of earners have been definitely lost and 23 and 18 per cents of them are either lost or are very probably on the way to it, resulting in the increase of unproductive families from 2 and 16 per cents to 31 and 40 per cents; a big jump of 29 and 24 per cents within the period of a year only! 396

Table 10 re[illegible] 566 12 the total number of earners in all the classes and the comparative importance of the occupations with regard to the earners in December, 1943. The earners have been classified as (*i*) leading earner, on the income of whom the particular family mainly depends, and (*ii*) working dependant whose income is an additional help to the family. Usually the leading earners are not below the age of 25 and the working dependants are within the age-grade of 15—25. The occupations have been classified as (*i*) primary and (*ii*) secondary with regard to their comparative importance. The occupations of the working dependants have always been noted as secondary. The table shows that agriculture is mainly the secondary sources of living for these people which further confirms the earlier statement that though these people live on agrarian economy, 'agriculture' (by which is meant the cultivation of their own land) provides for only a part of their livelihood. The table also shows that 7 leading earners of the class I depend on domestic service which means the occupations like husking paddy etc. by the females. This indicates the severity of distress in the class I where the seven families have to depend on the meagre income from this type of domestic service.

Table 10 has shown that in all there are only 93, 116, and 31 earners in the respective classes I, II, and III of which 85, 111, and 28 are the leading earners and the rest 8, 5 and 3 are the working dependants. That is, very few family units have more than one earner each, the total number of family units of the population studied being 85 in class I, 105 in class II, and 28 in class III. Table 11 which shows the effective population of these units considered together, that is, of the total population,

TABLE 10. Showing the total number of leading earners and working dependants in each occupation considered as primary or secondary in December 1943.

Source of Livelihood	Class I (N—85)					Class II (N—105)					Class III (N—28)				
		Primary	Secondary				Primary	Secondary				Primary	Secondary		
	No. of Family units	Leading earner	Leading earner	Working dependant	Total No. of Earners in each occupation	No. of Family units	Leading earner	Leading earner	Working dependant	Total No. of Earners in each occupation	No. of Family units	Leading earner	Leading earner	Working dependant	Total No. of Earners in each occupation
(Productive)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Agriculture	16	6	10	...	16	17	4	13	...	17	17	8	9	...	17
Labour	25	25	1	1	27	36	37	...	3	40	11	10	...	2	12
Domestic Service ...	7	7	...	5	12	1	1	...	1	2	...	...	...	...	...
Industry: Carpentry, Weaving, barber's job, and Washerman's job ...	3	4	...	1	5	7	9	1	...	10	...	...	...	...	...
Trade: Shop-keeping and Free Trading ...	2	5	...	...	5	2	5	...	...	5	2	4	...	...	4
Profession & Liberal Arts: Medical, Teaching and Priesthood	...	...	...	...	...	4	7	...	...	7	...	...	...	...	...
Any Other Occupation ...	11	13	...	1	14	6	6	...	...	6	1	4	...	1	5
Sub-total ...	54	60	11	8	...	63	69	14	4	...	26	26	9	3	...
Unproductive	31	31	...	...	...	42	42	...	1	...	2	2	...	...	...
Total ...	85	91	11	8	...	105	111	14	5	...	28	28	9	3	

indicates why there are not many earners in these family units.

Before discussing table 11 which gives us the distribution of the population according to age-grades one thing is to be noted. As has been mentioned in the beginning, the population was studied by the geneological method, with the help of which the population in December, 1943 was recorded. Now as there was no immigration during June—December, 1943 and the number of birth is negligible the population in May, 1943 can be deduced from it with a fair degree of accuracy considering the number of deaths and emigrations within the period of June—December. Following the same principle the population in May, 1942 may be deduced, though with still less accuracy but perhaps sufficient for our purpose of finding out the age-grade ratios, by considering the deaths alone leaving aside emigration which did not play any important part in this period. Thus the table 11 has been pre-
part in this period. Thus the table 11 has been pre-
grades, 0—15, 15—50 and above 50 of which the age-grade 15—50 may be considered to comprise of the effective population economically. The table shows that the age-grade ratio is practically the same in all the three periods, the percentages of total being 50, 43 and 7 in May 1942 and 51, 43 and 6 in December 1943 for the respective age-grades of 0—15, 15—50 and above 50.

However, as the table shows, the effective population belonging to the age-grade 15—50 covers 43 per cent of the total population. But it is to be noted that only a minor portion of the female population of these villages is directly effective with regard to the sources of income, since their only occupation for direct income in cash or kind is domestic service which accounts for only 5 per cent of the total number of earners when all the types are considered together. It is true that they are effective as housewife or household worker and also as assistants in some occupations, like Agriculture, Weaving, and Washermen's job, but they do not directly bring any money or anything in kind to the family except through domestic service already described. Therefore, to find out the really economically effective population we must consider only 5 per cent of the female population belonging to the age-group 16—50, which again is of greater percentage than the corresponding grade of the males. Hence, the percentages of the really effective population are only 24 and 26 in May, 1942 and December, 1943 respectively. In our sample also the percentage of total number of earners (246) to total population (962) is 25 per cent. These figures be why there are not many earners in the village that he result of this is that the earnings of most of the families were not sufficient to fight the food crisis. The earnings have been further curtailed now as there are 80 unproductive earners (30 per cent of the total) to be considered. The Census of 1941 records that in Bengal only 27 per cent of the total population is economically effective, that is, they earn something to maintain themselves and their family. It is clear therefore that the sample studied is sufficiently close to the norm of economic condition in Bengal.

TABLE 11. Showing the total population of the sample in December 1943, May 1943, and May 1942.

Age-grade	Population in Dec. 1943				Deaths within June-Nov. 1943			Emigration within June-Nov. 1943			Population in May 1943 (Cols. 1+2+3)				Deaths within June '42-May '43			Population in May 1942 (Cols. 4+5)			
	Male	Female	Total	P.C.	Male	Female	Total	Male	Female	Total	Male	Female	Total	P.C.	Male	Female	Total	Male	Female	Total	P.C.
	(1·1)	(1·2)	(1·3)	(1·4)	(2·1)	(2·2)	(2·3)	(3·1)	(3·2)	(3·3)	(4·1)	(4·2)	(4·3)	(4·4)	(5·1)	(5·2)	(5·2)	(6·1)	(6·2)	(6·3)	(6·4)
0—15	263	223	486	51	30	17	47	12	6	18	305	246	551	51	7	12	19	312	258	570	50
15—50	184	229	413	43	17	10	27	27	3	30	228	242	470	43	9	7	16	237	249	486	43
50 & above	38	25	63	6	4	1	5	...	...	...	42	26	68	6	4	4	8	46	30	76	7
Total ...	485	477	962	100	51	28	79	39	9	48	575	514	1089	100	20	23	43	595	537	1132	100

The effect of the food crisis on the population is best understood when we consider the deaths and emigrations that have taken place between June – November, 1943 when the crisis was raging very high. The deaths within the previous period of one year, from June, 1942—May 1943, is also considered to give a comparative picture. The emigrations in this period have not been taken into account as it was not at all an important phenomenon in this period. It may again be mentioned here that the death rates during June—November 1943, and June 1942—May 1943 have been calculated from the derived population figures of May 1943 and May, 1942 respectively as noted in the previous pages.

According to the table 12 the percentage death rates for the classes I, II and III in the six months from June to November, 1943 were 6, 9, and 3 respectively, that is, 12, 18 and 6 per cents in the year. What a staggering figure when the normal annual death rate is 2·3 per cent on the average* and when we find that during the year before, from June, 1942 to May 1943, the death rates per 100 were 4, 3, and 5 only.

TABLE 12. Showing the death-rates of the population in percentage during June—November 1943 and June 1942—May 1943

Class	Population in May 1943	Deaths in June—Nov. 1943		Population in May 1942	Deaths in June '42—May '43	
		Sample	Percentage		Sample	Percentage
	(1)	(2·1)	(2·2)	(3)	(3·1)	(3·2)
I	396	24	6	412	16	4
II	566	51	9	585	19	3
III	127	4	3	135	8	5
Total ...	1089	79	7	1132	43	4

Table 13 which gives a detailed analysis of deaths within June—November, 1943 with respect to age-grade and sex, indicates very high child mortality—17 per cent per year! Death in old age is also no less marked but that is however, less alarming than child mortality. The death rates according to sex reveal a very significant and at the same time an alarming phenomenon. At a glance it can be seen that more males have died than females, the ratio being roughly 2:1. That the association between death and sex is really significant is borne out by χ^2 test, as shown in the table. In χ^2 test, the expected value was regarded as equal proportions of male and female death rate (although even in normal times, as shown in Census of Bengal 1931, the female death rate is slightly higher than that of males, especially in age-groups of 0—15, and 16—50) and the observed value was the higher proportion of male death rate. The test proves that except in the age-group of above 50 to the two values are remarkably dissimilar and in case of the age-group 'Above 50' also the similarity is very slight. This indicates that there is association between mortality and sex, especially in the age-grades 0—15, 15—50, as well as in the total; that is, more males have died than females.

It is to be mentioned here that the usual large sample test indicates that the sex ratio of the sample studied may be said to represent the district population according to the Census of 1941† when the result of the test, $t = 1{\cdot}25$ and $p(t) = 21$ per cent. Hence this phenomenon of differential death rate may be regarded as applicable to the district as a whole.

TABLE 13. Showing the male and female death-rates of the total population in percentage in different age-grades during June—November 1943.

Age-grade	Population in May 1943			Deaths during June—November 1943: Sample			Deaths during June—November 1943: Percentage of total			χ^2 test on male & female death-rates to total population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	D. F.	χ^2	P
	(1·1)	(1·2)	(1·3)	(2·1)	(2·2)	(2·3)	(3·1)	(3·2)	(3·3)	(4·1)	(4·2)	(4·3)
0—15 ..	305	246	551	30	17	47	5·4	3·1	8·5	1	0·1414	>0·70
15—50 ..	228	242	470	17	10	27	3·6	2·1	5·7	1	0·3593	>0·50
50 & above ..	42	26	68	4	1	5	5·9	1·5	7·4	1	10·8532	<0·01‡
Total ..	575	514	1089	51	28	79	4·7	2·6	7·3	1	0·4248	>0·50

‡Significant.

*Calculated from Public Health Department figures during 1931-40.

$$\dagger\ t = \frac{\pi - p}{\sqrt{\frac{p(1-p)}{n}}};\ \pi = \frac{\text{Total male population of the district}}{\text{Total population of the district}} = \frac{1{,}143{,}174}{2{,}217{,}402} = 0{\cdot}52$$

$$= 1{\cdot}25 \quad ;\ p = \frac{\text{Total male population of the sample}}{\text{Total population of the sample}} = \frac{485}{962} = 0{\cdot}50$$

$$;\ n = 962.$$

As to the reason behind the differential death rate we cannot assert any. It may be due to the fact that the males had to exert much more than the females to avert the crisis, this being very probable regarding the effective male population, who being the leading earners of the family units had to exert their utmost to provide for their dependents, mostly female, and this exertion coupled with ill feeding or starvation, (which, however, was common to both) heavily told upon their health leading to death in large numbers.

Another feature, to be considered here, is that the difference of age of 5 years and not infrequently of 10 or even more is the usual rule with the married couples of these people, so that, the heads of the families who are frequently of middle age have their wives considerably younger to them who could stand this crisis in a better way than their husbands, and the latter being older were already of lower vitality and further had to bear more exertion. The result is that more males of this age-group have died than

TABLE 14. Showing the total number of deaths in different age-grades during June—November 1943.

Age-grade	Deaths: Male (1)	Deaths: Female (2)
0—5	19	11
5—10	7	6
10—15	4	...
15—20	3	1
20—30	...	3
30—40	6	4
40—50	8	2
50—60	2	...
60—70	1	...
70 and above	1	1

females. That this statement is true is further proved by the table 14 which shows the total number of deaths in the age-groups of 5 and 10 years' intervals. The table shows that the difference of male and female deaths is extremely marked in the age-group 40—50 where the total number of male deaths also is only next to that in the age-group 0—5.

Whatever the reason may be the absolute figures supplemented by the χ^2 test indicate it to be a fact that more males have died than females and this is surely going to affect the population very seriously in the long run, especially in case of the Hindus who look down upon widow marriage with contempt and who are now going to face a huge mass of widows in the present generation, (that is, belonging to the age-grade 15—50) and smaller number of women in the coming generation belonging to the age-grade of 0—15. The huge number of deaths within June—November, 1943 itself shows what has been the effect of food crisis on the population. Table 15 which records the cause of death within June—November, 1943 and June 1942—May 1943 further confirms it.

Table 15 shows that 44 per cent of the total deaths are due to the effects of starvation and of it 89 per cent took place during June—November, 1943. One thing, to be noted here, is that it is true that starvation is the cause of so many deaths as recorded in the table, but the actual deaths might have taken place due to some diseases which, when the entire bodily system is totally deranged by prolonged starvation, could very easily attack and finish off the

TABLE 15. Showing the cause of deaths within June—November 1943 and June 1942—May 1943.

Cause	Deaths: June-Nov. 1943 (1)	Deaths: June '42-May 1943 (2)	Total deaths within June '42—Nov. 1943: Sample (3)	Total deaths within June '42—Nov. 1943: Percentage (4)
Starvation ...	48	16	54	44
Dysentery ...	2	4	6	5
Dropsy ...	7	...	7	6
Fever (mostly Malaria) ...	9	13	22	18
Cholera ...	4	7	11	9
Small Pox ...	5	1	6	5
Other Causes ...	4	12	16	13
Total ...	79	43	122	100

persons. As in most of such cases the informants could not describe the consequent diseases correctly, the deaths have been recorded as due to starvation. Where the disease could be ascertained it has been noted, as seen in the table. Hence, if we consider dysentry, dropsy, fever and cholera to be the diseases which came in consequence of starvation we see that 82 per cent of the deaths are due to food crisis of which again 70 per cent took place during June—November 1943, when the crisis reached its height.

The study of the effect of the food crisis on the population remains incomplete unless something is known about the persons who have emigrated from the villages due to food crisis. We have already noted that a considerable percentage of the earners have left the villages in search of service in some other parts of Bengal and Assam or are untraced. Table 16 shows the total number of the rural population who have emigrated within June—November, 1943 due to the food crisis. As the figures will show, comparing these with those of table 9, most of the emigrants are the earners considered previously, but the females belonging to the age-group 16—50 and all of the age-group 0-15 (except 6 males who are working dependants) are the other family members,

dependants of the earners, who have also accompanied them.

institution among the Hindus, has been effected by the food crisis.

TABLE 16. Showing the emigration of the population during June—November 1943.

Class	Emigration within June—November 1943									Population in May '43	Emigration per 100
	0—15		15—50		50 and above		Total				
	Male	Female	Male	Female	Male	Female	Male	Female	Total		
	(1·1)	(1·2)	(2·1)	(2·2)	(3·1)	(3·2)	(4·1)	(4·2)	(4·3)	(5)	(6)
I	5	5	9	2	...	...	14	7	21	396	5
II	4	...	14	...	...	...	18	...	18	566	3
III	3	1	4	1	...	...	7	2	9	127	7

The table shows that 5, 3, and 7 per cents of the population have migrated due to food crisis within June—November, 1943. It also indicates that more males have emigrated than females and that the largest number has emigrated from the economically effective population. The table also indicates that not a single one of the older population has emigrated for the obvious reason that they have no more strength or urge to try their luck elsewhere and so prefer to die if that be the consequence, in the native place. On the whole, the figures on the population problem, so far considered, show that the effect of the food crisis on the rural population of the district of Noakhali is that only within a period of six months from June—November, 1943 6, 9 and 3 per cents of the population have died and 5, 3, and 7 per cents of it have emigrated. Also of the low proportion of economically effective population 6 and 4 per cents of the total number of earners belonging to class I and II have died out, 14 and 7 per cents have emigrated, and 15, 11, and 6 per cents of the classes I, II and III are invalids through starvation and various diseases which are the consequence of starvation. This is how the food crisis has led the rural population towards physical extinction.

Effect of the Food Crisis on the Social Life of the People

Sufficient data as to how the food crisis is effecting the social life of these people could not be collected within the short period of field work. But in all the villages it was found that Hindus of various castes, like, Kayastha, Napit (Barber), Dhupi (Washerman), Jugi (Weaver), (as shown in table 17 where the class I sample, as mentioned in the beginning, belongs to the gruel kitchens) are taking their food from the same gruel kitchens; the Muhammedans having a separate kitchen. It indicates that even the caste system, the most dominant social

Another feature, to be noted, is that except one family unit under the class II all other found in the villages are simple families composed of the parents and children with rarely a married son. Infrequently there is also a widowed mother or sister or daughter. The system of joint family, so popular in Bengal is practically non-existent. How far this is due to the present food crisis or is the result of the constant deterioration of the economic life of the rural population from a considerable time requires further investigation. However it was found out that the widowed persons who are commonly looked after by the nearest relatives, like, brother or father in rural families have been made to live apart in many cases. At the time of investigation it was found out that in a Muhammedan family belonging to class I an old woman has very recently been put apart by her son and is not provided by him anymore, so that, she has to live with her two grand children by. another son, dead long ago, depending solely on begging. In class II two cases were observed—one Hindu and the other Mohammedan—where the families have left the villages and gone to Assam leaving behind their two widowed sisters. In two other families, and in this case also one Hindu and one Muhammedan, the widowed sisters are not provided for any more and they have to live separately even when the two families are there in the villages. These two persons maintain themselves by domestic service and charity. Detailed investigation regarding such disruption in the usual social life could not be carried out, but these few instances indicate how due to the food crisis the social tie has been loosened when nobody cares to look after any other person.

This feature was more sharply brought out in case of three families of class II and of one of class III, the heads of which have sold their eight daughters between 10 to 22 years of age, to some persons hailing from Jessore who came there to procure girls for marriage, at Jessore. It is not definitely

known whether the girls are really married in Jessore or are utilised for immoral purposes, as they themselves could not be sure on this point. The fact remains that the severity of the food crisis has made these people so inhuman that they have sold their daughters even though their future was unknown. Another person, the head of another family unit belonging to class II, told us that he also wants to sell his daughter in this way but cannot do it as the girl has no proper clothes to wear!

TABLE 17. Showing the total number of families and persons, according to community and caste, of the population in December 1943

Community, Caste or Sect	Family Units			Population		
	Class			Class		
	I (N-85)	II (N-105)	III (N-28)	I (N-352)	II (N-496)	III (N-114)
	(1)	(2)	(3)	(4)	(5)	(6)
Brahmin	...	2	...	...	14	...
Kayastha	11	27	...	56	158	...
Napit (Barber)	3	1	...	16	1	...
Jugi (Weaver)	1	11	...	4	44	...
Karmakar (Blacksmith) ...	...	4	...	...	10	...
Sutradhar (Carpenter) ...	...	2	...	...	11	...
Dhupi (Washerman) ...	13	7	...	42	26	...
Bairagi (Vaishnaba sect) ...	...	2	...	...	3	...
Natya (Dancer—intermediate between Hindu & Muslim) ...	...	2	...	...	9	...
Hindu	28	58	...	118	276	...
Muslim	57	47	28	234	220	114

The report can now be summed up as follows. Through the study of the three classes of families I have tried to find out the effect of the food crisis on the people of the district as a whole. Although I could not collect a large volume of data, yet the three samples studied may be considered to be the cross-sections of the life of the people of the district where the class I represents the most affected, the class II those affected in a lesser degree, and the class III, the general population of the district of any village who may not have received any relief. The fact and figures prove that this last group is nevertheless affected. This study has revealed that the effect of the food crisis in case of all the types is the same in quality, the variation being only of degree.* Every where, in all cases, the food crisis has economically ruined the people bringing many of them to total destitution. Biologically it has led them to extinction at a tremendous speed and socially it has disrupted their normal family ties and turned them into callous beings bereft of human sympathy and feelings.

This is the effect of food crisis of 1943 on the rural population of the district of Noakhali. It will totally crush these people unless proper steps are taken to rehabilitate them.

* The figures regarding the class III seem to show that this class is not so adversely affected as the other two. It may be that this is the real fact. But we must also bear in mind that our sample is very small with regard to this class (only 28 family units being studied). Hence it may not accurately show the severity of distress of the people belonging to this class.

NEW NOBEL LAUREATES IN CHEMISTRY AND PHYSIOLOGY

PROF. GEORGE V. HEVESY is the recipient of the Nobel Prize in Chemistry for 1943. His main work and notable contributions lie in the field of X-ray Spectrography as applied to the study of chemical problems and in the sphere of radio-activity. His work on the separation of isotopes is also an outstanding one.

In collaboration with Bronsted in 1921, he succeeded in effecting partial separation of the isotopes of mercury and chlorine by fractional distillation under conditions of the so-called ideal distillation, in which the molecules leaving the surface were not allowed to return. Following the same method in 1927, he effected partial separation of the isotopes of potassium and proved that K^{39} is not responsible for the activity of potassium.

In 1922, following the suggestions offered by Bohr's theory of atomic structure, he, in collaboration with Coster, examined numerous zirconium minerals by the X-ray method, which led to the discovery of hafnium, the element No. 72, and proved it to be a homologue of zirconium and not a rare earth element as was believed by Urbain and others. The chemistry of hafnium was developed and elucidated entirely by him. Micro-chemical analysis by means of X-ray spectrography forms also an important feature of his contributions to chemistry.

By far the largest amount of his work lies in the field of radio-activity and specially in connection with the use of radio-elements as indicators. Mention may be made in this connection of (1) the use of thorium B as indicator for the determination of the solubility of lead chromate in water, (2) exchange between bivalent and quadrivalent lead ions in solution, (3) determination of deposition potential of poloniam and bismuth, which verifies Nernst's formula for deposition voltage even in extremely dilute solutions of the order of 10^{-8} N, (4) the use of radio-elements as indicators in colloid chemistry, (5) study of self-diffusion in solid metallic lead and lead salts, as well as the interchange of lead atoms between fused lead and fused lead chloride, and between lead oxide and lead sulphide, (6) absorption and distribution of lead in roots, leaves and fruits of a plant; and the use of radio-active isotope P^{32} in the study of metabolic processes. The nature of radio-activity of the rare earth element samarium was first studied and established by him. He was one of those who investigated the nuclear transmutation of the rare earth elements.

Hevesy was an Ordentlicher Professor of Physical Chemistry for several years in the University of Freiburg from where he went to Stockholm before the outbreak of the present war. He is the author of several well-known and standard books like 'Die Seltenen Erden vom Standpunkte des Atombaues' (Rare-earths from the standpoint of Atomic Structure), 'Chemical Analysis by X-rays', and a 'Manual of Radio-Activity' (with Paneth).

P. Rây.

H. S. GASSER and J. Erlanger were the joint recipients of Nobel Prize for Physiology for 1943, as was announced sometime ago. They achieved their distinction by their brilliant work in the domain of biophysics of nerves in relation to the study of their action potentials by greatly improved technique, *viz.*, by Cathode Ray Oscillograph after suitable amplification, and by their equally brilliant analysis of the results of this study. Although the main part of this work was done by Gasser in collaboration with Erlanger, yet others such as Newcomer, Bishop, Graham, Grundfest, and Blair helped him to a considerable extent in elucidating these problems. Before their work it was known that when a nerve is stimulated, a chain of processes giving electrical, potential signs is set up. The algebraic sum of these potentials is called the "action potential". In an intact nerve the action potential is di-phasic in nature, but if the nerve is damaged at one end, as by the application of a hot wire, the leads from an uninjured and the injured portions of the nerve show a mono-phasic variation or a mono-phasic wave. Gasser *et al* showed by eliminating diphasicity by potassium method and by applying refined technique that the monophasic action potential wave is not simple but composite, consisting of one larger potential change followed by smaller and slower potential changes which are masked in the di-phasic wave. The larger potential change is the spike potential and the subsequent smaller and slower changes, the after-potentials. These after-potentials consist of a negative after-potential starting while the spike is in progress and finally the positive after-potential which appears after the ending of the negative after-potential. The negative potential is of variable magnitude and duration and the positive potential is very small in frog's nerve fibres, but is sharply defined, constant in form, position and occurrence in those mammalian nerve fibres in which the velocity of transmission of impulse is very fast (*i.e.*, A-fibres).

The duration of spike potential is about 0·4 m. sec.; of this the period of rising potential is ⅓ and of the falling potential ⅔ of the time (*i.e.*, of 0·4 m. sec.). The negative after-potential which begins while the spike is in progress reaches zero at about 15 m. sec. from the beginning of the curve. It is then succeeded by the positive after-potential which reaches a maximum at about 30 m. sec. but continues to about 70 m. sec. The potential of the spike at its peak is about 12 mv. Regarding the magnitude of the negative after potential, though no definite value can be given because of its overlapping with the spike, yet there are reasons to believe that it is about 5 to 6 per cent. of the maximum spike potential. The crest of positive after-potential has a value of 20 to 25 μv., *i.e.*, about 0·2 per cent. of the spike potential.

In freshly mounted (in air or O_2) isolated nerves, in which the fibres are subject to spontaneous discharges, such as the phrenic nerve, the after-potential is rhythmic, *i.e.*, in addition to negative and positive phases, there may be a second cycle of negative and positive waves, and even a third and a fourth one, the discharges increasing during the negative phases and decreasing during the positive phases. Tetanisation and veratrinasation augment both the negative and positive potentials.

Recovery of excitability in a nerve after stimulation was studied in relation to these various phases of action potentials. The absolute refractory period coincides generally with the duration of the spike potential and lasts between 0·41 and 0·44 m. sec. in best preparations, although not infrequently, no sign of a second response can be evoked unless the shock interval is 0·5 m. sec. In nerves functioning under physiological conditions the relative refractory state ends at about 3 m. sec. and the supernormal phase lies between 3 and 15 m. sec. with a maximum of 7 per cent. at 7 m. sec.; subnormality is shown between 15 and 70 m. sec. with a maximum of 3 per cent. at 30 m. sec. In isolated nerves the relative refractory period is shortened by the augmented negative after-potential process and supernormality which coincides generally with the negative after-potential comes on early. In nerves *in situ* the relative refractory period is longer and the supernormal phase is less in degree and shorter in duration. The subnormal phase coincides with the positive after-potential period. Fresh nerves (isolated) show less negativity and less supernormality. In cases, such as after tetanisation where the negative after-potential is sufficiently augmented along with the positive after-potential, the complete cycle through which the excitability of a fibre passes before returning to its steady state is made up of: the refractory period, a first supernormal and then a first subnormal period, a second supernormal and then a second subnormal period.

In an earlier period of their work, when they first used the lagless instrument, *viz.*, Cathode Ray Oscillograph, for recording action potentials, they noticed that secondary waves occur in the catacrotic limb of the action potential curve. They soon realised that these waves are discrete action potentials originating simultaneously with the main action current but travelling at different rates in fibres possessing different physiological characteristics, for when the action potential of a mixed nerve is recorded by leads placed close to the site of stimulation, it is simple in form; if the leads are placed at a distance of 31 mm., the catacrotic limb shows a hump; if at 82 mm., three or sometimes four separate waves are clearly seen. These waves are called α, β, γ, and δ waves. The three usual waves, *viz.*, α, β and γ, have the same general form but the α-wave has the greatest and the γ-wave the smallest amplitude. These waves may be compared to scratch runners in a race who, though starting together, gradually get separated at longer distances from the start since the faster contestants outstrip the slower. On studying the course of transmission of these waves from the sciatic nerve to its spinal roots, it was noticed that the α-wave is composite, consisting of a sole motor component which passes into anterior roots and α-sensory component which passes into posterior roots. The fibres contributing to these 2 waves have about the same stimulation threshold and rates of conduction. It was further noticed that β, γ and δ waves are entirely sensory and like the α-sensory wave pass into posterior roots only. On stimulation of a motor branch of the femoral nerve α-waves alone are obtained and of a branch of the same nerve going to the skin β and γ waves and not α-waves are obtained. It was, therefore, concluded that α-waves are produced in large efferent (motor) and afferent (muscle sense) fibres of the muscular branch and β and γ waves in afferent fibres subserving skin sensations. All these fibres (α, β and γ) enter somatic nerves *via* spinal roots. In studying the relation between the activity of a nerve, as revealed by its electrical sign, and its morphology these workers found that a correlation exists between fibre size and the velocity of the action potential wave. Thus three groups of myelinated fibres existing in the peroneal nerve of a frog with diameters of nearly 16, 10 and 5 microns are found to be responsible for the conductance of α, β and γ waves respectively. In the sciatic nerve of dogs and cats the velocities of propagation of α β and γ waves are 90, 50 and 30 meters per sec., whereas their velocities in the corresponding nerve of bull frog vary between 50 to 10 meters per sec. Thus the greater the diameter of a fibre, the faster

is its conduction rate. The excitability and the length of the refractory period of the fibre also varies with the diameter, the smaller ones possessing a higher threshold and a longer refractory period than the larger.

On applying a stimulus much stronger than that required to elicit α, β, γ (and sometimes δ) waves from a mixed nerve and on greatly increasing the amplification of the instrument these workers found that two other waves (or series of waves) appear if the action potential is recorded from the nerve at a distance of 91 mm. from the seat of stimulation. The first of these appears about 15σ (*i.e.*, m. sec.) after the crest of the γ-wave and the 2nd wave appears about 110σ after the termination of the former. Gasser and Erlanger called these B and C waves and included α, β, γ (sometimes δ) waves in A group of waves. The B elevation is sometimes compound like A and the C elevation is usually so. In a mixed nerve A group comprises all those myelinated fibres of which the diameter is 5 μ or upwards, and B and C groups include such myelinated fibres as have a diameter less than 5 μ and unmyelinated fibres.* The conduction rates of B fibres vary between 20 and 10 meters per sec. in dogs and cats and between 5·5 and 1·3 m. per sec. in bull frogs and of C fibres between 1·6 and 0·3 m. per sec. in the former (*i.e.*, dogs and cats) and between 0·9 and 0·2 m. per sec. in bull frogs. The irritability of A fibres is maximal, that of B intermediate and of C the least. B fibres enter the mixed spinal nerve through grey rami and are accordingly post anglionic sympathetic fibres. C fibres are found in (*a*) anterior roots and white rami (therefore efferent, myelinated pre-ganglionic sympathetic fibres), (*b*) grey rami, and (*c*) posterior roots, in which they are non-myelinated. They possibly transmit sensations of pain and are concerned in antidromic dilatation and sherrington contracture.

* The correlation between fibre size and conduction rates that is seen in the case of A group of fibres is not noticed in the case of B and C groups.

The work of Gasser and Erlanger once more proves how important is the application of Physics to problems of Physiology. Co-operation or rather combined action between Physicists and Physiologists is essential for the development of Biophysics in this country, for it is rarely that the same individual has a conjoint training in both mathematical physics and higher physiology. It is to be remembered and realised that if a distinction is made between the status of Physicists and Physiologists in the course of such co-operative work, the growth of Biophysics is likely to be hampered.

N. M. Basu

Notes and News

NOBEL AWARDS IN PHYSICS & CHEMISTRY

CLOSE at the heels of the report of the Nobel awards in Physiology and Medicine for 1943 and 1944 comes the announcement of the like awards in Physics and Chemistry for the same years. Prof. O. Stern of the Carnegie Institute of Technology, Pittsburg, Pennsylvania, has received the Nobel Prize for Physics for 1943. Prof. Stern developed the technique for the study of atomic beams and experimentally demonstrated, in conjunction with W. Gerlach, the directional quantization of atoms, and also determined the magnetic moments. In 1933 he determined the magnetic moment of proton. He was Professor of Experimental Physics in the University of Hamburg till 1933.

The Prize for Physics for 1944 has been awarded to Prof. Rabi of Columbia University, New York. He began his investigations in Hamburg under Prof. Stern, and with his co-workers has extensively developed the method of atomic beams for the measurement of nuclear magnetic moments of unprecedented accuracy.

Prof. George von Hevesy of Stockholm has been awarded the Nobel Prize for Chemistry for 1943. He developed the use of isotopes as indicators in the study of chemical processes and of biological metabolism. The award in Chemistry for 1944 has been reserved until next year.

PROGRESS OF TELE-COMMUNICATIONS IN INDIA

AN unofficial note relating to the activities and developments of the Indian Posts and Telegraphs Department contains a useful account of the recent progress of tele-communications in India. An exten-

sive scheme for tele-communications development, estimated to cost Rs. 17,00,00,000 and scheduled to be completed in 1944-45, was undertaken in the middle of 1942 in response to the growing needs of the Defence Department. The scheme provides for a five-fold increase in the number of telegraph and telephone channels between the main centres in India for civil and defence purposes and, in addition, seeks to introduce extensive wire communications required by the Defence Services. One hundred and twenty-three thousand miles of wire (with 11,000 miles of new routes) will connect all important cities, enabling a number of messages to be transmitted on a single pair of wires at the same time. Provision has also been made for the expansion of local telephone systems in various places, amounting to 20,000 new connections. Over 100 telephone and nearly 350 telegraph channels are reported to have already been added. Nearly 2,000 miles of post route and over 10,000 miles of wire have been erected so far. Over and above this, 4,000 miles of line and 60,000 miles of wire have been erected for meeting the operational needs of the Defence Services since the outbreak of the war.

It is heartening to learn of such expansion in the tele-communication services in India. But dispite all these expansions tele-communication services still cater to an insignificantly small fraction of the Indian population, crowded in a few scattered cities, large and small. These services are mostly unknown to more than 85 per cent. of India's 400 million people, dwelling in about 700,000 villages, and as such are fraught with the possibilities of an immense development in future when more men and women will be released from the plough to the factories.

MICA ENQUIRY COMMITTEE

The Central Government, according to a press note issued by the Labour Department, New Delhi, have appointed a Mica Enquiry Committee to enquire into the immediate as well as the long term problems of mica mining industry. The Hon'ble Mr Justice E. E. Reuben, I.C.S., of the Patna High Court, has been appointed Chairman, and Rai Bahadur Rai Hardatta Prasad, Secretary to the Committee. The Committee will be assisted in their investigations by assessors from the mica trade and industry and by technical advisers from the Geological Survey of India and the Board of Scientific and Industrial Research.

While the Committee will generally enquire into and report on all problems relating to the mica industry and its present and future developments, it will specifically examine and report on immediate problems relating to the Mica Control Order, 1940, both in regard to war production and long term policy. The Committee will further review any orders that may have been passed by Government in connection with that Order, such as the present system of marketing both inland and abroad, standardization of quality, the extent to which alternative sources of supply may have jeopardized or are likely to jeopardize the position of India as the principal supplier of muscovite mica, the extent to which other materials that may be used as substitutes for mica may have displaced or are likely to displace mica from its uses in the industry, increased utilization of mica in India for the manufacture of finished goods, methods of development with special reference to research, conservation, mining, processing, marketing and meeting competition, and the desirability of setting up a suitable machinery whether by the appointment of a Central Mica Committee or otherwise to watch the interests of the mica trade and industry. The Committee will have its headquarters at Patna and will tour in mica mining areas to take evidence on the spot.

THE GREAT ENGLISH INDIAN DICTIONARY

The readers of Science and Culture will be interested to know that the International Academy of Indian Culture has undertaken to prepare and publish an exhaustive Indian Dictionary of technical, semi-technical and literary words covering the entire range of human thought and life. The work started in 1934 under the inspiring guidance of Dr Raghu Vira, the editor-in-chief and founder of the Academy, with the co-operation of a number of distinguished scientists, linguists, literary men and educationists drawn from all parts of India and constituting the editorial board. The experiments in the formation of suitable terms could take the finished form only in 1943, and the first fascicule was printed in July 1943 in Devanagri. This was soon followed by the second fascicule which was issued in December, 1943 in Devanagri, Bengali, Kanarese and Tamil. Since then progress in the preparation of the Dictionary has been steady, and the first volume on inorganic chemistry has been completed.

The Great English Indian Dictionary, as it has been styled, will contain Indian equivalents for every word of the English language, literary, technical and semi-technical, covering about six hundred special branches of knowledge. The Oxford Dictionary in thirteen volumes and the Webster's Dictionary in two volumes serve as the main sources for English vocabulary. The Indian words are derived from Sanskrit roots and stems and are such as are usuable in the diverse literary languages of India and Ceylon, whether Aryan or Dravidian. Every word appears in four scripts, *e.g.*, Devanagri and Bengali for Northern

India, and Canarese and Tamil for Southern India. To indicate the range of information, attention may be drawn to the first volume on inorganic chemistry just completed. It contains the elements, their derivatives and compounds, symbols, prefixes and suffixes, etc. It has further been provided with an introduction dealing with some of the principles underlying the terminology and with two appendices containing the verbs derived from the names of elements and the names of rocks and minerals connected with the element names.

The Dictionary appears in fascicules, and those of the first volume on chemistry are now appearing every month. The publication will cover a period of ten years and will entail a total cost estimated at about ten lacks of rupees.

The importance of such a work need hardly be overestimated. The Dictionary, when completed, is expected to serve as a valuable reference book for translators and authors of technical books in Indian languages, which are destined to play a great part in the future educational development of India.

HIGHER SALARIES FOR TEACHERS

At a meeting of the Teachers' Committee on Higher Education, appointed by the Central Advisory Board of Education, held in Simla on October 2 and attended by distinguished educationists from all parts of India, Sir Jogendra Singh, Member for Education, Health and Lands, said:

"It used to be argued that teachers should practise the virtues of contentment and plain living and take their vocation in a missionary spirit of service to the community and that they ought not to look for worldly reward. Teaching is indeed a form of social service, but in the words of the McNair Committee Report, like other professions 'it is also a bread and butter affair. The missionary spirit cannot be relied upon to maintain the supply and the morale of millions of teachers.'

"There are in British India 16 universities and 13 higher institutions for research of university rank, besides 430 colleges of different types affiliated to universities. It is not unknown to the members of this committee that grave harm has been done to education by recruiting teachers on cheap salaries irrespective of their attainments, and some of the best minds have been lost to the profession owing to this fact. What was said in the earlier committee's report is also true of university teachers. If the teaching service is to secure an adequate supply of the right type of people it must offer practical attractions comparable with those which other branches of public services offer to their members."

It is encouraging to hear such words from the Hon'ble the Member for Education, Health and Lands. But criticisms of this type are not new; it is time for positive action and for the initiation of practical steps to improve the teachers' financial lot. We are interested to know how and how soon the Government propose to give effect to their proposals for ensuing an adequate scale of salary for teachers.

INDUSTRIAL RESEARCH

The Industrial Research Planning Committee, according to a report of *Hindu*, recently held meetings in Bombay to discuss problems of general strengthening of the scientific departments of universities and scientific institutes of university rank, questions relating to the establishment of administrative machinery for guiding and co-ordinating industrial research, and the setting up of a Bureau of Standards under the central organization for industrial research. Representatives of the University of Bombay discussed with the Committee questions relating to the making of a block grant to the universities for the improvement of equipment in their existing scientific departments and for the organization and development of new scientific departments according to the requirements and resources of different regions. The Committee further met the representatives of the Indian Merchants' Chamber and the All-India Manufacturers' Organization and discussed the question of establishing a suitable administrative machinery with adequate representation of scientific and industrial interests for guiding and co-ordinating industrial research on a comprehensive basis. In connection with this administrative machinery such questions as the exploitation of research processes through a National Board of Trustees and the extent to which available facilities in research institutions were used by industry were also discussed. Finally, the Committee examined the possibility of establishing a Bureau of Standards under the auspices of the Central Organization for industrial research and discussed the nature of the relationship the proposed Bureau should have with the National Physical Laboratory and various other testing laboratories.

Recommendations of the Committee are not yet available. Meanwhile the All-India Manufacturers' Organization has submitted a memorandum, and we understand that several of the recommendations contained in the memorandum have been accepted for inclusion in the Committee's report.

TRAINED PERSONNEL FOR INDIA

At his first press conference after assumption of office, Sir Ardeshir Dalal, Member for Planning and Development, explained the Government policy regarding the problem of the supply of trained personnel in India. He expressed his conviction that the training of scientists, engineers, geologists, doctors, agriculturists, educationists, administrators etc. for innumerable different jobs requiring their services was the most essential preliminary step. "To my mind," said Sir Ardeshir, "the question of personnel is probably the most serious of the difficulties in the way of planning and is likely to impose well-defined limits to the pace of development". The solu-

tion, in his opinion, lies in the expansion and multiplication of educational institutions and in the generous provisions for scholarships and research studentships to enable Indian students to prosecute higher studies both in this country and abroad. Sir Ardeshir revealed that the Government intended to send a large number of men to receive training in the U.K., and the U.S.A. in the near future. In fact, Mr John Sargent, Educational Adviser to the Government of India, has now been visiting these countries with a view to exploring the possibilities of making such arrangements and is expected to submit his detailed scheme when he returns to India. Furthermore, the Government now have had under consideration the establishment of a very high grade technological institute on the lines of the M.I.T. in the U.S.A. and also of an All-India Medical Centre.

PROPOSED PANELS FOR INDUSTRIES

THE first meeting of the Policy Committee on Industries, which took place towards the end of October, provided another occasion for Sir Ardeshir Dalal to revert to the Government policy particularly with regard to the development of industries. The Government, it would appear, are inclined to favour the development of industries on a regional basis. The provinces have been requested to form development committees and offices of their own and draw up plans for the establishment of industries suited to their areas. But what is more important the Government have proposed to set up a number of panels for investigating the problems of the development of individual industries or groups of industries. The final plans will be developed after due consideration and co-ordination of the proposals put forward by the provincial committees and panels for industries.

It is proposed to attach to each of these panels one or more experts, according to requirements, as well as a permanent officer of the Planning Department. The panels will be constituted in close consultations with the Supply and Industries and Civil Supplies Departments. It may be necessary to obtain the services of some experts from outside to deal with certain industries. Where there are fully representative and authoritative associations representing any particular industry, such as the Central Board for the cotton textile industry, set up by the Government and fully capable of dealing with all questions pertaining to this industry in India, creation of panels is unnecessary and will not be attempted. But such associations are not many, and panels may be profitably established in several industries and groups of industries. Besides there are industries involving highly complicated technical processes, which would call for the advice of more than one expert to decide the feasibility of establishing them in this country. Shipbuilding, air-craft, manufacture of large electrical machinery, plastics, dyestuffs etc. are instances of such industries, panels for which will make general recommendations regarding their feasibility and location.

Sir Ardeshir assures us that it is the intention not only to start new industries and to maintain and expand the existing ones with the help of imported machinery, but to make, as far as possible, such machinery in this country.

FRENCH SCIENCE DURING GERMAN OCCUPATION

The American weekly *Time*, October 16th, 1944, gives some news of the work of the French scientists during the German occupation of France. Paul Langevin, the 72 years old veteran physicist has returned to Paris from Switzerland ; a reception was given at Sorborne in his honour. Langevin was arrested in October 1940 while at his post in L'Ecole de Physique. After being imprisoned for two months, he was released as a result of protest riots in which several students were killed. The underground movement helped him to escape from house arrest at Troyes and cross the border. His son-in-law, Jacques Solomon, was amongst the organizers of the clandestine scientific journal *Z'Univusite Libres*. It is reported that all of the organizers were shot by the Nazis. Fedric Joliot, son-in-law of Madame Curie had his troubles. His laboratories at Paris and Ivry were seized in June 1941, and he had a twelve hour ordeal with the Gestapo. He came through well enough to get back his laboratories and the only French owned cyclotron and a precious stock of radium.

It appears that Alexis Carrel, the well-known experimental biologist and author of the books 'The Culture of Organs' and 'Man the Unknown', was the only first rank scientist who collaborated with the Vichy Government ; he was provided with plenty of funds for investigations of human problems discussed in his last named book. After the liberation of Paris, Carrel was suspended from his post as director of the research foundation which is being placed under a new management by Joliot.

NEW FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA

At the meeting of the Council of the National Institute of Sciences of India, held on the 30th October, 1944, the following were duly declared to have been elected Ordinary and Honorary Fellows of the National Institute :

ORDINARY FELLOWS

Prof. Bashir Ahmad, Professor of Organic and Bio-chemistry, Punjab University, Lahore ; Prof. N.

M. Basu, Senior Professor of Physiology, Presidency College, Calcutta; Dr P. N. Bhaduri, Lecturer in Botany, University College of Science, Calcutta; Dr P. K. Bose, Deputy Director of Productions of Drugs and Dressings, Department of Supply, New Delhi; Dr Hamid Khan (Bhatti), Game Warden, Punjab, Lahore; Dr S. B. Khastgir, Reader in Physics, Dacca University, Dacca; Dr M. G. Kini, Surgeon and Superintendent, Stanley Hospital, Madras; Dr Subodh Mitra, Associate Professor of Midwifery, Carmichael Medical College, Calcutta; Dr G. Panja, Professor of Bacteriology and Pathology, School of Tropical Medicine, Calcutta; Prof. B. Sanjiva Rao, Head of the Department of Chemistry, Mysore University, Bangalore; Mr S. N. Roy, Lecturer in Statistics, Calcutta University, Calcutta; Dr B. N. Uppal, Plant Pathologist to Government of Bombay, Poona.

Honorary Fellows

Sir Henry Hallett Dale, President, Royal Society of London; Prof. A. V. Hill, Secretary, Royal Society of London.

ANNOUNCEMENTS

We regret to announce the death of Prof. Sir Ralph Fowler, F.R.S., Plummer Professor of Theoretical Physics, Cambridge University, at the age of fifty-five. He was the son-in-law of Lord Rutherford. We shall publish a biographical sketch of this well-known mathematical physicist in our next issue.

We deeply regret to record the death of Sir Arthur Eddington, Professor of Astronomy in the Cambridge University and Director of the Observatory at Cambridge at the age of 61. He was one of the leading astro-physicists of the present time. The world science has sustained an irreparable loss through his death. A fuller account of Sir Eddington's life and work will be published in a subsequent issue.

News has just been received from London that Mr B. B. Ray, B.Sc. Hons. (Physics) Calcutta, B.Sc. Hons. (Eng.) London, M.Sc. (Eng.) London, A.M.I.E.E. has been admitted to the Fellowship of the Institute of Physics, London. It is understood the honour was bestowed on him on the merits of his work in connection with voltage regulation problem. Mr Ray is at present in charge of Electricity under the Government of Orissa.

SCIENCE IN INDUSTRY

COLOUR TELEVISION

Some time ago, a reporter of the *News Chronicle* related the story of the three dimensional colour television developed and recently demonstrated by Mr J. L. Baird. The new television set is the result of three years of research and for the first time makes possible the reception of television in colour as well as in depth so as to make the images closely resemble objects in three dimensions as well as in natural colours. A short account of the technical features of the television set has appeared in *Nature*, September 23, 1944.

In his new set, Mr Baird has dispensed with the mechanical moving parts such as the revolving disks and lenses and has introduced electronic devices. He has developed a special cathode ray tube, termed a 'Telechrome', which reproduces the received pictures. The tube is provided with a doubled sided transparent screen coated on both sides with fluorescent powders of the appropriate colours. Two cathode ray beams modulated by the incoming signals corresponding to two pictures of a subject, taken in primary colours, are allowed to impinge obliquely on opposite sides of the screen. The screen develops on its front face an image containing the orange-red colour components and on its back an image with the blue-green components. The two images blend and give rise to an image in natural colour. The pictures in colour have further been used to produce sterioscopic effects.

Mr Baird demonstrated the reception of colour television with the help of such a tube containing a screen, 10 in. in diameter. Pictures were received from a 600-line triple interlaced moving spot transmitter using a cathode ray tube in combination with a revolving disk with orange-red and blue-green filters. The screen developed a very bright picture with good matching of colours, due partly to the absence of colour filters and partly to the use of special fluorescent powders.

Mr Baird is also reported to have perfected another method in which he has used three colours. The back of the screen which is ridged is coated with blue and green powders. The blue and green pictures

are transmitted on the back of the screen, while the third beam containing the red component of the picture impinges on the front of the screen.

RELAXATION METHODS

THE calculation of stresses in highly redundant frames has always presented a complex and laborious problem. Several methods have been devised for their solution, and the one that has been lately propounded is the Relaxation method. It has been worked out by Professor Southwell, F.R.S., the distinguished designer of aircraft structures and investigator of the Theory of Elasticity. In this method he has sought to assess the range and power of a new approach to physical and engineering calculations by what is termed "the systematic relaxation of constraints." By the orthodox methods *viz.*, those based on Castigliano's principle of minimum strain energy, attention is focussed on the quantities whose values are sought, with the result that some difficulty is experienced in trying to formulate and solve the large number of simultaneous equations involved therein. In the Relaxation method the procedure is, as it were, reversed, attenton being concentrated on the specified quantities *viz.*, the external loading, and not on the quantities whose values are sought, these quantities in a braced framework representing the stresses or joint displacements in the required configuration. The object of this reversed procedure is to liquidate the external forces, by relaxing each specified constraint which is imposed on a joint, in such a way, that after a few operations the magnitude of the residual forces is very negligible. Thus, though the liquidation is not exact, it is always within some margin, covered by the practical margin of uncertainty. The logicality of this statement is based on the fact that it is only in theoretical or invented problems that the external loading and other data can be specified with certainty: in practice loadings are uncertain to the same or very nearly the same extent as the elastic nature and properties of the structure.

The distinguishing feature of this method, as compared with the other already in use for the determination of stresses in statically indeterminate structures, is that although attention is concentrated on residual forces, the operations required for their liquidation are also recorded, with the result that action in each and every member of the framework can be readily computed, *i.e.*, not only are the values of stresses available, but even the resulting distortion of the framework can be deduced. Besides, redundancy has almost no effect upon the time required for the solution, which, as it were represents the most significant feature in the Relaxation method.

As the basis of the whole Relaxation procedure rests on fundamental principles of Statics, the present method is found to have applications in far wider fields in engineering. By the use of what is termed Block and Group Relaxations, stresses and strains can be conveniently determined in a framework of several bays, (like a Warren truss) or in a continuous beam having several supports, or in the wing spars and bays of aeroplanes, which present by far the most complicated of all the problems in stress analysis.

In fields where investigation is still continuing, Relaxation methods are applied to the problems of free and forced vibrations, torsion and flexure problems of St. Venant, determination of currents, and potentials in electrical networks and the normalization of simultaneous equations.

Poisson's equation in two dimensions, when solved by Relaxation methods, finds application in the theories of Elasticity and Earth Pressure, in problems of Plastic Torsion, and the stiffened Suspension Bridge, the latter in connection with non-linear systems.

It is hoped that these, and the further investigations which take place will materially benefit the science of engineering in all its branches, and lay in the hands of a designer a powerful and useful tool, for all types of complex structural analysis and research.

S. K. G.

RADIO HEAT DEHYDRATES PENICILLIN

DEHYDRATION of penicillin has presented a great problem to vacuum engineering. Ordinary methods of evaporation by heating are, however, not applicable as these involve the risk of the loss of potency of the drug. Accordingly, the process of bulk reduction by evaporation in a high vacuum at temperatures below the freezing point has been frequently resorted to during recent years. Such methods are technically described as "freeze-drying".

Meanwhile, according to a report in *Science*, Dr George H. Brown, research engineer of the Radio Corporation of America, has developed a method of dehydrating penicillin by radio heat, which is reported to be forty-eight time as fast as the present "freeze drying" method. Experiments on this electronic process were carried out at the new E. R. Squibb penicillin production plant at New Brunswick. The speed of drying may be reflected from the fact that in 24 hours enough penicillin was dehydrated to treat 4,000 patients each requiring 500,000 units of the mold chemical. Besides the saving in time, the new electronic process has several other advantages of which the following may be mentioned: (1) Reduction in operating cost equivalent to the saving of one ton of dry ice a day or about 65 per 24 hours, (2) Reduction in maintenance costs, (3) Smoother flow of productions,

(4) Reduction in floor space requirements by nearly 10 times, (5) Saving in initial investment of several hundred per cent.

VERNALIZATION OF RICE

THIS method of inducing earliness and increased yield of rice is reported by Dr S. M. Sarker of the Botany Department, Calcutta University, in *Nature*, March 25, 1944.

In a winter variety of rice *e.g.*, *Bhasamanik*, 7 days old seedlings were exposed to short days (8 to 10 hours of daylight) for varying periods up to 6 weeks in the seed bed. The seedlings were later transplanted in pots and grown in the field under natural long days. This accelerates ear emergence by about 10 days and increase grain yield by about 16 per cent. With prolonged short days *i.e.*, until the ear emergence, earliness was induced by about 25 days and increased grain yield by 35 per cent. The application of the method in field practices is only possible by the treatment of seedlings in the seed bed. These results are of remarkable agricultural importance for the variety of rice grown after transplantation. In temperate cereals *e.g.*, wheat and winter rye, similar earliness in flowering has also been effected by seedlings treated to exposures of different light periods.

BEEDI LEAF INDUSTRY IN INDIA

DUE to the shrinkage of imports of cheap foreign cigarettes owing to the war, the *beedi* leaf industry is expanding very rapidly. Revenue from this product has become one of the most important items of forest revenue.

The Indian forest leaflet No. 60 (silviculture) contains all the information that exists with a view to helping increased and better production of the cheap smoke. The subject is of great importance as in the present war conditions the demand for tobacco paper has increased enormously.

The object of this note is to indicate what type of experimental research is necessary for improving the production and quality of leaves for *beedi* wrappers. The leaves of many indigenous plants are used for wrapping tobacco, but *Diospyros melanoxylon* is the species per excellence generally preferred due to the peculiar flavour, flexibility in texture and resistance to early decay, as compared with the leaves of other species. *Diospyros melanoxylon* is one of the characteristic trees of the dry mixed deciduous forests of the Indian peninsula. In Bihar, Bombay, Central Provinces, Madras and Orissa, this is extensively used for *beedis*.

Details of quantity and quality of production of these leaves, of the time of collection, processes of drying, storage, packing and transport, and suggestions for experimental research with regard to pollarding and methods of drying which is subject to variations of weather *e.g.*, heavy rainfall, are detailed in this leaflet.

SOME ASPECTS OF FRUIT CANNING INDUSTRY

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IF photography has brought to us the panoramic sites of various countries, if radio has brought the lilting melodies of different people of the world, canning has done much more. It has brought the delicacies of different nations to our dinner table. No longer need we dwell in the realm of imagination as to the flavour of the Californian string beans or Hawaiian pine apples or English strawberries, we can taste them. The fruit canning industry has made fruits such as peaches, apricots and pine apples familiar to hundreds of thousands of families all over the world who would have known of these only by sight or names. It is the convenience rather than the cheapness that is the main attraction of canned foods and these are available in all their variety at any time of the year and in any climate. Canned food is ready for serving and therefore there is very little wastage and further expense. Canning has done much more. It has helped armies fighting in out of the way places, navies guarding isolated places of strategic importance and explorers exploring the wilds of Africa or the snowy expanse of the Arctic or Antartic to enjoy rich nourishing food in their natural flavour.

The old methods of drying, salting and smoking served the purpose to some extent but it was felt in the latter half of the eighteenth century that some better methods of preserving foods should be found, methods which could protect foods from spoilage for a considerable period. Young Nicholas Appert, brought up as a chef, had set up in business as a maker of confections in Paris. In about 1780 he felt

such a necessity and the year 1794 saw the opening of a small factory by Appert for bottling of foods. He filled the food stuffs in a wide mouthed bottle, kept them standing brimful in boiling water for sometime and then sealed them with alternate layers of cork and wax.

The introduction of tin canisters for the purpose of filling food by Peter Durand in 1810 in England was a great advance in the canning industry and since then this industry began to develop in England, America and Europe. The tin can has gone through numerous improvements. The cumbersome use of cans with vent holes which were exhausted and then sealed with solder was replaced by the invention of open topped can which is a land mark in the history of canning industry. Today various types of cans are available—plain tin cans, lacquered tin cans and cans with special enamel linings to prevent the bleaching of coloured fruits and the staining of the inside of the can such as occurs with sulphur bearing fruits and vegetables and meat products when packed in plain cans.

Fruit Canning Operations

The fruit canning operations whether done with hand or by machines are essentially the same. The fruits to be canned are first sorted, graded and washed. Then the stalks and calcyces are removed and the fruits are peeled, cored and trimmed or cut into slices. Next they are steam blanched and filled into cans and syruped. The skins of certain fruits like peaches have to be softened by scolding them in hot water or steam or by the use of caustic soda or lye (lye-peeling) for a few seconds, the strength of the solution being about 1 to 3 per cent. The blanching of fruits and vegetables either with steam or hot water has the additional advantage of softening and shrinking them in order to obtain a well filled can or bottle after cooking, as also of driving out from the tissues a great deal of air which might otherwise remain to promote corrosion. The quantity of fruit and sugar used in canning has to be carefully controlled both from the point of view of flavour and economy.

Syruping over, the cans are exhausted by immersing the open cans filled with fruit and syrup as hot as possible, in a large covered tank containing hot water, to within one inch of their top and made to travel through at a regulated rate. The water in the bath is kept at about 180—190°F and the cans usually emerge with their contents at a temperature of about 160°F. The lids are then placed in position, automatically clinched on and rolled tight by the double seaming machine. Then comes the sealing and this is a very important process as the success of the whole canning process depends on obtaining a perfect seal. This too is a mechanical process. The next operation is that of processing of canned fruits which has for its object the destruction of bacteria and fungi which would otherwise cause spoilage. With fruits this operation is rendered comparatively easy on account of the high acidity of the products and they are readily sterilised at the temperature of boiling water or even at a lower temperature. With vegetables and meat it is more difficult. The latter are subject to spoilage by thermophilic and other heat resisting spore forming bacteria among which is the well known Bacillus botulinus. They must therefore be sterilised by heating in retorts at temperatures of 240° or 250°F for a length of time sufficient to destroy such organisms. After sterilisation the cans are cooled, labelled and stored in the proper place so as to avoid getting rusted.

Of late, bottling of fruits has been practised extensively. The advantages of bottling are—the almost complete elimination of the trouble of corrosion except of caps in the case of bottles with metal caps and the visibility of the product from the outside thus enabling the consumer to actually see what he is buying. Against these are the disadvantages of breakages during transport or sterilisation and the decolourisation of some fruits, especially red fruits, due to exposure to light. The process of bottling fruits is essentially the same as the canning of fruits. The trouble of corrosion has been eliminated by the use of caps which have been lacquered inside and with rubber gaskets to fit tightly. Breakages have been reduced by the manufacture of glass which can withstand sudden changes of temperature.

Spoilage of Canned Fruits

Spoilage of canned fruits may be due to various causes. It may be due to the growth of microorganisms such as moulds, yeasts or bacteria, present either through under sterilisation or leaks, due to the corrosion of the tin or iron of which the can is made resulting in discolouration of the contents and in the formation of hydrogen swells and perforations or due to the over filling of the cans or the use of dented or rusty cans.

Hydrogen swells and perforations are caused by the formation of hydrogen in cans by the action of the fruit acids on the tin and iron of which the can is made. When this attack is concentrated at certain spots so as to cause pitting, the can may actually become perforated. Other causes of hydrogen swells are the presence of substances such as sulphides which accelerate corrosion of iron with products of high acidity, storage of canned goods at high temperature, inefficient cooling of the cans after processing, presence of substances which encourage detinning and so on. The remedy for this trouble lies

in proper control in the factory, especially in filling, exhausting and sealing, by storage in cool places, use of sugar free from sulphur compounds and by adjusting the acidity of the syrup.

Discolouration of canned fruits may be either due to injury or over riping or due to the presence of sulphur compounds in the sugar used or due to the use of sulphur sprays or fungicides on the fruits used for canning or due to the presence of sulphur compounds in the fruit itself. Fruits containing authocyanine like various berries often undergo changes due to contact with metals like iron, aluminium, copper, tin etc. Pipes, pans, utensils etc. should therefore be made of stainless steel or other metals which do not affect the authocyanins. Many fruits like apples, pears and peaches rapidly turn brown or show other colour changes. Such fruits have been found to contain what is known as the oxidase system which is a system of enzymes which acts upon certain aromatic substances. This system is completely destroyed by heat and it is checked in its action by storage at 32°—40°F or by a weak brine or sugar solution. Each fruit has its own idiosyncrasy and the best canning conditions have to be evolved for each fruit separately. Hirst and Adam[1] have published a useful report dealing with the idiosyncrasies of various fruits and the steps which should be taken to reduce the trouble. The review of Ball[2] on the different methods for sterilising canned foods and that of Cameron[3] on the control of contamination both of the raw products and in the canning plant may also be read with profit by the canners.

Canned foods and Health

Canned foods may be harmful for three reasons. They may not be as nutritive as fresh foods, poisonous products like tin and lead salts may have been formed and lastly harmful bacilli might be present.

With regard to the nutritive value of canned foods it has been found as a result of extensive work that the nutritive value of canned foods does not change much on canning. Loss of vitamins is not much and is certainly never more than that occurring in ordinary cooking. It has been found that with lacquered cans the tin content after a year's storage rarely exceeds 30 parts per million. Therefore, for practical purposes tin poisoning from canned foods does not occur. With regard to lead poisoning it has been found that except in very rare cases there is no risk of lead poisoning from canned foods.

Another type of poisoning known popularly as 'Ptomaine poisoning' hindered the growth of canning industry for some time, especially in America. Ptomaines are poisonous substances in the product present only when the process of decomposition has advanced so far as to make the food-stuffs too revolting to be eaten. The assertions that ptomaine poisoning was due to canned foods have been more often than not found to be entirely without foundation though it must be admitted that the toxin type of outbreak is sometimes associated with canned foods for it so happens that in processing though the living bacilli are destroyed the heating is not invariably successful in destroying the preformed toxins. In many cases it has been found that the outbreak of epidemics from eating canned foods have been traced to products of low acidity canned in home under conditions of inadequate heat sterilisation.

A few years back a large scale investigation[5] was carried out in England in which nearly 1700 rats were used in four successive generations. One group was fed entirely on canned foods, the other on the comparable fresh foods. It was found that the performances of the two groups in respect of breeding, growth and composition of the body as a whole as well as of the bones and teeth separately were in all respects comparable.

The practical experience of the French Mission to Greenland in 1932-33 when 15 men lived for 13 months on canned foods almost entirely without fresh foods and found no poisoning or nutritional defects and the millions of people who eat canned foods day after day without any ill effects are eloquent testimonies to the harmlessness of canned foods.

Fruit Canning Industry in India

The growth of canning industry in India is of recent origin. Still it is in its infancy. Small scale fruit canning is being done all over India but there are only about half a dozen canneries in India which may be considered to be of some importance. Though our fruit production is very much short of requirements from the point of view of nutrition and self sufficiency, with the extention of fruit plantations it is necessary to develop the fruit preservation industries in order that the produce may not go to waste when transport is not available or due to a glut in the market, but besides these to replace the present imports of preserved fruits by our own and to develop a foreign trade in preserved fruits and thus bring prosperity to the poor horticulturists of this country.

It is necessary to encourage the consumption of fruits by cheapening them owing to the nutritive value of the fruits and canning of fruits ensures this supply to those who can afford them in the off-season. The area under fruits and vegetables is about 1·9 per cent of the net area sown if the figures for the year 1939-40 are taken. There is a considerable amount of uncultivated land classed as "cultivable waste other than fallow" by which is meant land available for cultivation but not taken up or abandoned, and "current fallows" by which is meant land

left uncultivated for a certain period. A part of such land may be brought under fruit cultivation wherever facilities for irrigation exist by encouraging such cultivation by granting concessions to those who are prepared to do so. Hilly regions offer scope for English and Mediterranean fruits and the plains and the peninsular area for tropical and subtropical fruits. The information in respect of each fruit regarding the soils and climate suitable and the other factors necessary for the successful cultivation along with the survey of pests and diseases and their remedies, manurial treatments for different fruit plantations with the time of application and other information of importance to the fruit growers like sorting, grading etc. of fruits should be disseminated through the proper agencies like the government department of agriculture in a language which the cultivators can understand.

Extension of fruit cultivation would be also desirable because "the cultivation of fruits leads to the employment of far more labour than the cultivation of other crops" (Sir John Russell). There is ample market for fresh fruits in this country and if the fruits can be sold at cheaper rates than is now being done, by extensive cultivation, cheaper transport etc. many more people will be able to buy fruits and this will result not only in an improvement in the condition of the fruit growers but will improve the condition of malnutrition so widely prevalent in this country.

Requirements of Fruits for Canning[6, 7]

Fruits meant for canning have to fulfil certain requirements and these are to some extent different than those of the fresh fruit market. Canneries accept generally only those varieties which remain firm and lose little of their colour when subjected to the heating and sterilising processes. Appearance is important many a times more than the flavour and the interplay of these two qualities flavour and appearance therefore affect the course of the industry. This necessitates those in charge of canneries to be in direct touch with the market and study its likes and dislikes.

The fruits for canning must be of similar grades so as to maintain a regularity of count in the canned products which is essential not only for the restaurant or catering trade but also for the private consumer to whom it would be irritating if the can cannot be relied upon to give the usual number of pieces. Another factor of vital importance to the canning industry is the regularity of supplies of the raw products at prices that fluctuate little from year to year. If the supplies are not regular the smooth working of the factory is bound to be hampered, labour will have to be kept idle or turned out, thus endangering harmonious relations between capital and labour, overhead costs are bound to be higher for these will be lowest per tin when the factory works at its maximum.

Sulphur dioxide must not be used for preserving fruits intended for canning. Similiarly the use of sulphur sprays or fungicides may also give the canned fruits a disagreeable odour.

Colour, flavour and texture are important considerations in choosing the time for picking and the particular variety of fruit to be canned. It is therefore essential in view of the considerations outlined above that the grower should study the needs of the cannery and plan his production accordingly. In countries like the U.S.A., Canada and South Africa which have advanced considerably in fruit canning industry the cannery agrees to buy the whole crop from a stated acreage at a fixed price per ton, if the production be of a certain standard. The canneries usually employ a field man to advise growers on choice of varieties and other problems of cultivation.

Containers

In the fruit canning industry the cost of the container is one of the main causes of great disparity in the price of the raw fruit and the canned article and forms more than ¼ of the total cost of production even in foreign countries well advanced in canning industry.[8] In India it is still more and is over ⅓ the total cost of production as we have to import the containers from outside. The cans used in general are wrought iron tin plates which are lacquered. Such plates are not manufactured in India at present. Even if the tin plates are manufactured in India the question of satisfactory lacquering will remain. Other types of containers like suitable types of bottles and jars are not available in large quantities and the few available are costly. If the cans are manufactured in India the cost of production will decrease as the cans will be available at about 30 to 40 per cent less price. It is therefore necessary that along with the establishment of fruit canning factories either the canning factories themselves or some other parties undertake the manufacture of cans. The price of the containers is a factor of vital importance for the success of the canning industry and self-sufficiency against foreign sources of supplies of containers would be a great step towards the success of our canning industry.

Standards for Canned Fruits

In all the countries with well advanced canning industry there are certain standards known as the quality standards according to which the products

are classed. Complex regulations have been enforced on the canning industry in various countries to protect the consumer, the grower and the canner alike from each other and amongst themselves in the case of the canners. Standards are provided for syrup strength, colouring matters to be used, forms of records, labelling equipment, factory procedure, stock control and so on. Countries like U. S. A. and Great Britain have even reduced the number of can sizes and specifications for the capacity, height, diameter etc. are given. These standards are fixed up by boards consisting of representatives of industry and government. It is needless to say that in this country also standards must be fixed by the government or by a board consisting of representatives of canning concerns and the government to put a check on spurious products being sold and also to let the public know what they are buying. The U. S. A. Department of Agriculture is responsible for grade definitions covering production throughout the States. In England the Ministry of Agriculture originated a voluntary scheme in June 1930 known as the National Mark Scheme and set up standards. The "Australian Canned Fruits Control Board" regulates the industry in Australia. "The Central Board of Pineapple Packers, Malaya" regulates the pineapple canning industry in Malaya. The government exercises control over these boards and hence over the industry through their representatives in these boards.

(To be continued)

MEDICINE AND PUBLIC HEALTH

VACCINES WITH ULTRAVIOLET LIGHT

A NEW method of preparing vaccines against a number of diseases, entailing the use of ultraviolet light, has been reported in the *Journal of the American Medical Association* (June 24). The use of ultraviolet light to inactivate germs is, however, not new and was practised in the past with varying degrees of success. But the old technique frequently destroys not only the germs but also their immunizing properties. On the other hand, insufficient irradiation failing to destroy the disease-causing property has on more than one occasion produced fatal results. Accordingly, the older technique hardly guaranteed the production of uniformly safe and potent vaccines.

The new method employing ultraviolet light, it is claimed, completely and almost instantaneously kills germs of both bacteria and virus classes without destroying the potency of the vaccines. A newly developed ultraviolet lamp serves as a powerful source of both total and extreme ultraviolet light, the extreme being below 2,000 Å. Germs in suspensions exposed to such ultraviolet light in continuously flowing thin films are killed in less than one second.

The vaccines thus produced appear to be equal, or superior in antigenic potency, to thermally killed vaccines prepared from the same bacterial suspensions. For instance, rabies vaccine prepared by the new technique induced a higher degree of immunity in mice than vaccines in which germs had been killed by phenol. Six month's storage at a temperature slightly above the freezing point did not adversely affect the potency of the vaccine. Animal experiments with a vaccine against sleeping sickness, prepared according to the new method, indicated that mice indeed developed a high degree of immunity.

A number of vaccines such as those against typhoid fever, pneumonia type I, and salmonella enteritidis (responsible for food poisoning) have already been prepared by this method.

WORK ON INFLUENZA AND A NEW KIND OF PNEUMONIA

A *Science News Letter* report places on record the results of investigations of a number of U. S. doctors working for the Army regarding the vaccination against influenza. It was known from previous experiments that inhaling sprayed blood serum from persons recovered from influenza would protect against the disease. But results obtained by such inhalation are not always assuring. This led the investigators to try the vaccination method in the case of influenza, and the results appear to indicate that vaccination offers more hope of protection against influenza.

The serum they used for testing the value of third method of giving protection against influenza was not the same as that used in tests at the Naval Laboratory Research Unit at the University of California under the direction of Capt. Albert P. Krueger. In the Navy tests a globulin fraction of influenza immune horse, not human, serum was

found to give protection to laboratory animals. Although this is encouraging, nothing conclusive as to results of human immunization is known yet because tests have not been carried out on a large enough scale. After two years of study of the problem, however, Capt. Krueger's group is coming more to the view that injecting the serum under the skin would be more practical than giving it by inhalation because of the greater certainty that the necessary amount would be assimilated.

The report further refers to a study of a kind of pneumonia which has recently caused great anxiety in some parts of the Tennessee Valley. This is variously known as virus pneumonia and primary atypical pneumonia. It has symptoms different from those of pneumococcal pneumonia and does not respond to treatment with serums or sulpha drugs. Such primary atypical pneumonia has been transmitted for the first time by spraying washings from the noses of persons previously suffering from the disease into the noses of healthy, sound objectors who volunteered for the purpose. Such transmission studies may help to isolate the germ for which work is now in progress.

SOME TRENDS IN BACTERIAL CHEMOTHERAPY

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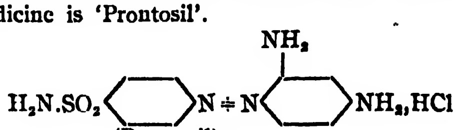
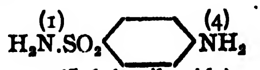
THE endeavour of man to search out the right chemotherapeutical agents to combat infectious diseases has been crowned with success only in recent times. Most spectacular in degree of success has been that attained in this decade first with the dye, prontosil and then with the derivatives of sulphanilamide. The key to the newer chemotherapy was provided primarily by the discovery of the anti-streptococcal activity of azo-dyes derived from sulphanilamide, an essentially fundamental advance resulting from the perseverence and genius of Domagk.[1] This discovery stimulated interest in ascertaining the most effective members of this class of dyes ; the only way to find them out was to make as many of these as possible and try them out. Mietzsch and Klarer, collaborating with Domagk, prepared more than thousand such compounds. Many of these were active in experimental streptococcal infections though, strangely enough, outside the bodies of test animals, *i.e.*, *in vitro*, they were but feeble disinfectants. The most effective of this multitude which has had considerable application in medicine is 'Prontosil'.



(Prontosil)



(Sulphanilamide)

The next step forward was taken by French workers[2] at the Pasteur Institute who showed that the activity of prontosil was due to its being cleaved in the animal body to a much simpler substance, sulphanilamide which had been known[3] since 1908 under the chemical name of *p*-aminobenzene sulphonamide.

The success of prontosil and later of sulphanilamide attracted to the new field hundreds of workers who hoped to discover substances which would be as good as, or better than, either of these or would be free from their many undesirable by-and after-effects and by means of which the range of therapeutic usefulness could be widened.

The chemists set to work on the molecular skeleton of sulphanilamide. Research centered chiefly on the synthesis of nuclear, N^1-, and N^4- substituted derivatives. The compounds with substituents in the benzene ring were usually inactive. By substitutions at the N^4- position, a series of N^4- acyl ammo, nitro, hydroxylamino, azo, anil and reduced anil derivatives were obtained. Although it has not been proved beyond doubt that the activities of these compounds[3, 4] are entirely the result of cleavage with liberation of sulphanilamide, there is much evidence pointing to such a mechanism. One of these compounds which has found some clinical

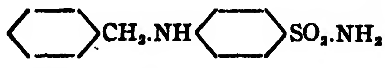
[1] Domagk, *Deut. Med. Wochschr. 61*, 250, 929, 1935; Mietzsch and Klarer, D.R.P., 607, 537, 1932.

[2] Tréfouël *et al.*, *Compt. rend. soc. biol.*, *120*, 756, 1935.

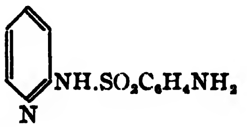
[3] Gelmo, *J. Prakt. Chem.*, *77*, 369, 1908.

[4] Fuller, *Lancet*, *1*, 194, 1937; Marshall *et al.*, *Proc. Soc. Exp. Biol. Med.*, *42*, 849, 1939; Molitor and Robinson, *J. Pharmacol.*, *65*, 405, 1939.

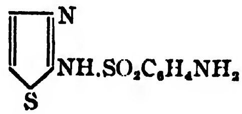
application by virtue of its activity and low toxicity is N^4 – benzyl sulphanilamide[5] or 'proseptasine'.—



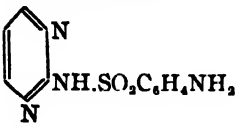
Substitution at the N^1 – or sulphonamide part of the molecule brought forth a far more interesting group of compounds. From the practical standpoint, the best results were obtained in this group, particularly, those derived from simple heterocycles.



(Sulphapyridine)



(Sulphathiazole)



(Sulphadiazine)

(Sulphaguanidine)

The spectacular success of sulphapyridine[6] was followed in quick succession by that of sulphathiazole,[7] a compound superior to sulphanilamide and sulphapyridine in some respects, and by that of sulphaguanidine[8] and sulphadiazine.[9] A few others like sulphapyrazine,[10] sulphathiazoline[11] etc., which appear promising from preliminary trials, have yet to win their spurs for a definite place in clinical practice.

Research from the purely chemical side has brought forth anywhere between three to four thousand new compounds, but curiously enough out of the hundreds of compounds that have come to light only a few have so far received wide practical application and have been recognized as important remedies. The reasons are not far to seek. The pharmacological and bacteriological studies have been unable to keep up the pace set by the chemists. Furthermore, the knowledge accumulated so far regarding their activity and pharmacology should in many instances be taken only as qualitatively indicative due, among other reasons, to a lack of co-ordination among the early workers and the adoption of universal test methods for ascertaining the real value of the sulphonamides and their toxic reactions. A survey of the formulae of the sulphonamides together with their reported activities brings to light many curious generalities. It is beyond comprehension why a particular arrangement of atoms, more than any others, should alone give rise to therapeutically valuable compounds and how the slightest changes in the molecular structure could sometimes completely alter the physiological picture by destroying or accentuating its previous properties or result in compounds with totally new and unpredicted characteristics. A rational approach to the sulphonamides has moreover been delayed by the usual first wave of numerous over-enthusiastic publications embodying preliminary successes and failures, incident to the introduction of new remedies. The latter in their turn have given rise to numerous anomolies, surprises and contradictions in the published literature. In addition, the secrecy surrounding the patent literature and work deliberately maintained by some of the commercial and other vested interests has prevented research workers from profiting by each other's conclusions, always a fertile source of inspiration, has tended to the unnecessary duplication of labours and has been, to a large extent, prejudicial to the progress of chemotherapy. A fruitful line of approach likely to furnish useful information would have been a unified effort to consolidate the positions already gained, namely, concentration on synthetic elaboration of the structural types that have so far been revealed to be of value. Nevertheless, one marvels at the amount of valuable work that has been carried out and yet cannot resist the feeling that much more could have been achieved by a closer co-operation between the chemist, the bacteriologist, the pharmacologist, the clinician and the pathologist as a consequence of hard, unremitting and systematic toil. It is therefore little wonder that the search for new members of this group of compounds remained, since the time of its inception till very recently, of necessity largely a matter of empirical conjecture, and the chemist has had to follow any 'lead' that looked promising or depend on 'lucky strikes'. In the present state of knowledge the conviction grows stronger that, except in a very limited sense, no large scale generalizations or axioms are yet admissible and that the attempt to correlate chemical constitution with antibacterial action even in the sulphonamide

[5] Goissedet *et al.*, *Compt. rend. soc. biol.*, *121*, 1082, 1939; Halpern and Mayer, *Presse Med.*, *29*, 201, 1936; May and Baker Co., *Brit. Pat.* 465, 914, 1937; Mayer, *Bull. Acad. Med.*, *127*, 727, 1937; Whitby, *Lancet*, *1*, 1517, 1937; Buttle *et al.*, *Biochem. J.*, *31*, 724, 1937.

[6] May and Baker Co., *Brit. Pat.*, 1516, 288, 1938; Whitby, *Lancect*, *1*, 1210, 1938; New and Non-official Remedies, *J. Amer. Med. Assoc.*, *114*, 326, 1940.

[7] Fosbinder and Walter, *J. Amer. Chem. Soc.*, *61*, 2032, 1939; Long, *J. Amer. Med. Assoc.*, *114*, 870, 1940.

[8] Marshall *et al.*, *Bull. Johns Hopkins Hosp.*, *67*, 163, 1940; *67*, 94, 1941; Lyon, W. Va., *Med. J.*, *37*, 54, 1941.

[9] Roblin *et al.*, *J. Amer. Chem. Soc.*, *62*, 2002, 1940; Feinstone *et al.*, *Bull. Johns Hopkins Hosp.*, *67*, 427, 1940; Klinefelter, *Proc. Soc. Exp. Biol. Med.*, *46*, 591, 1941; Long, *J. Amer. Med. Assoc.*, *116*, 2399, 1941; *Bull. Johns Hopkins Hosp.*, *69*, 297, 303, 314, 1941.

[10] Ellingson, *J. Amer. Chem. Soc.*, *63*, 2524, 1941; Raiziss *et al.*, *Ibid.*, *63*, 2739, 1941; Sausville aid Spoerri, *Ibid.*, *63*, 3153, 1941; Reugsegger *et al.*, *J. Amer Med. Sci.*, *202*, 432, 1941.

[11] Sprague and Kissinger, *J. Amer. Chem. Soc.*, *63*, 578, 1941; Raiziss and Clemence, *Ibid. 63*, 2739, 3124, 1941; Rajagopalan and others, *Ind. Pat.*, 28706.

group may not be possible until the many existing gaps in our knowledge are finally bridged.

In the sulphanilamide group of drugs, medical science has acquired a powerful weapon for the conquest of bacteria. Their wide and varied applications have been the subject of reviews and monographs.[12] They are of especial value in many streptococcal, pneumococcal, staphylococcal, meningococcal and gonococcal infections. They are also effective in some strains of the dysentery bacillus, Hemophilius influenza, the Welch bacillus and certain members of the Pasteurella group, including the plague bacillus. In addition, they possess remarkable curative effects in certain human urinary tract infections. While recounting the many spectacular successes of chemotherapy, we must not forget its present limitations which are not as widely published. There is still a long list of bacterial diseases uninfluenced by any drugs. Tuberculosis, leprosy, typhoid, paratyphoid, cholera, whooping cough, tetanus and certain kinds of pneumonia are not yet amenable to chemotherapy. In virus infections, the results so far obtained are mostly negative or inconclusive with the exception of lymphogranuloma and trachoma which are susceptible to treatment with the sulphonamides. However, the main body of the virus diseases, small-pox, measles, infantile paralysis, cold, influenza, etc., are not checked by the newer chemotherapeuticals. Like most other potent chemotherapeutical agents, the sulphonamides possess a certain amount of concomitant side effects and toxic reactions. Their deleterious effect on hemopoiesis of susceptible individuals is amongst the most dangerous of their toxic effects. Several cases of bone marrow depression, as evidenced by leucopenia with agranulocytosis or thrombocytopenia, have been reported by large or small doses of the drugs and must be considered as their real drawbacks. Cases of agranulocytosis are fortunately rather rare and the drugs would seem to be only as dangerous as any of the general anaesthetics.

While it is indeed difficult to conceive of any other development which has been of greater service to the human race than that which has taken place in the sulphonamide group of drugs, sulphonamides appear only to constitute the first of a series of powerful weapons for the swift and effective conquest of numerous diseases of bacterial origin in a new age of rational antisepsis that is but just dawning.

[12] Mellon, Gross and Cooper, 'Sulfanilamide Therapy of Bacterial Infections', 1938; Findley, 'Recent Advances in Chemotherapy', 1939; Bliss and Long, 'Clinical and Experimental Use of Sulfanilamide, Sulfapyridine and Allied Compounds', 1939; Carey, *J. Amer. Med. Assoc.*, *115*, 924, 1940; Kohlmer, *Arch. Internal Med.*, *65*, 671, 1940; Lockwood, *J. Amer. Med. Assoc.*, *115*, 1190, 1940; Long, *Bull. N. Y. Acad. Med.*, *16*, 732, 1940; Marshall, *Science*, *91*, 345, 1940; *An. Rev. Physiol.*, *3*, 643, 1941; Northey, *Chem. Revs.*, *27*, 85, 1940; Reimann, *Arch. Internal Med.*, *66*, 478, 1940; *68*, 325, 1941.

A rational basis of chemotherapy awaits establishment, firstly, of a chemical relationship between the causative agents of infectious diseases and the changes they bring about to result in a pathological condition, and, secondly, of the mode of action of chemotherapeutic agents. It is therefore gratifying to note that the past three years have witnessed an ever-increasing attention being directed towards the discovery of fundamental laws correlating physicochemical properties and physiological action. Indeed studies of the ways in which chemotherapeutic activity varies with chemical structures and physical properties have in the past achieved notable practical results, for example, the work done on the relation between narcotic action and lipoid solubility and between the action of chaulmoogra analogues on acid-fast organisms and their activity in depressing the surface tension of water. Among others, a recent communication, "Chemistry and Physics of Antiseptics in Relation to Mode of Action" by Albert[13] will amply bear out the above statement. There is no doubt that such studies would help to remove the empiricism that has hitherto been largely obtaining in the practice of bacterial chemotherapy so that the "rational approach" envisaged by Paul Fildes[14] (1940) might come to be the basis of the future search for new and better chemotherapeuticals.

No other group of chemotherapeutical investigations can perhaps claim to be more stimulating and of greater interest than those which have centered round the mode of action of the sulphonamide group of drugs. Sulphonamide chemotherapy may be said to have passed from the empirical to the rational with the discovery by Fildes[14] and Woods[15] of the mode of action of sulphanilamide. Their precise disclosure of its point of attack in chemical terms not only settled an acute controversy but opened the door to further development on more sure and promising lines. Attempts to explain antibacterial action in terms of specific inhibition of some essential metabolic steps have been greatly stimulated by the discovery that *p*-amino benzoic acid (PAB) is an essential metabolite, a fact now established experimentally[17], and that the drug, by virtue of similarity in chemical structure, can compete with it for some enzyme essential to the bacterial cell.[15, 16] The theory of Fildes and Woods that the action of sulphanilamide on hemolytic streptococci and other bacteria is simply to prevent the utilization of a substance

[13] Albert, *Lancet*, *2*, 633, 1942.
[14] Fildes, *ibid.*, *1*, 955, 1940.
[15] Woods, *Brit. J. Exp. Path.*, *21*, 74, 1940.
[16] Dorfman *et al.*, *Lancet*, *2*, 42, 1942.
[17] Rubbo and Gillespie, *Nature*, *146*, 838, 1940; Lampen and Peterson, *J Amer. Chem. Soc.*, *63*, 2283, 1941; Moller and Schwartz, *Ber.*, *74*, 1612, 1941; Kuhn and Schwartz., *ibid.*, *74*, 1617, 1941; Park and Wood, *Bull. John Hopkins Hosp.*, *70*, 19, 1942.

vitally essential for their growth, namely *p*-amino benzoic acid, has now gained general acceptance. This concept has been extended[18] in recent times to cover the other well-known sulphonamides also; the varying potencies of the latter have been explained by the additional effect of the heterocyclic halves of their molecules on other metabolic processes peculiar to or more important to the particular bacterium under consideration.[19, 20]

One of the consequences of the postulate of Fildes and Woods is the greater attention paid with some degree of success to interpret chemotherapy through nutritional studies. Thanks largely to the earlier work of Fildes and his collaborators, various substances other than PAB of well-defined chemical constitutions, now referred to as essential growth-factors, are known to be necessary for the growth of many pathogenic bacteria. Nutritional analyses, chiefly by McIlwain, show that bacteria in the presence of anti-bacterial agents require more substance than are usually needed for their growth. The inhibitors (antibacterial agents) therefore increase the nutritional requirements of bacteria. Some substances found necessary for bacterial growth (aneurin, cozymase) take part in the enzyme reactions, and these reactions account for the organism's need of such substances. The additional substances for which need is established by inhibitors are probably required in order to take part in reactions which have been affected by inhibitor.

Enzyme systems can in many cases be considered to correspond to the 'receptors' of Ehrlich. The structural specificity required for drug action is comparable to that required in growth essentials. Some grouping in one drug may be toxophoric by virtue of its similarity to a group in a growth essential; the $-SO_2.NH_2$ of sulphanilamide simulates the $-CO_2.H$ of PAB to a degree sufficient to react with and block enzymes which are essential and normally react with PAB. According to this view, chemotherapeutic interference is due to the functional replacement by the interfering agent of substances whose metabolism is affected by the inhibitor. Acriflavine and some arsenicals interfere, among other processes, with hydrogen transport which interfering agents like methylene blue are capable of performing.

From such considerations, McIlwain and his associates[21] were able to lay down successfully rules regarding structural specifications in possible chemotherapeuticals required for drug action. They were also responsible for actually demonstrating that slight but definite variations in the architecture of the "essential growth-factors" led to the production of enzyme analogues; the latter were then able to effect a competetive inhibition of the utilization of the normal growth-factors, resulting in metabolic disturbances in the organisms and their ultimate death. Thus a fundamentally new and promising approach to chemotherapy has now been thrown open. A few examples, at this stage, will be illustrative.

The belief that β-trisubstituted propionic acids would be inhibitory to the growth of *M. tuberculosis*, of which phthioic acid – a trisubstituted acetic acid— is a normal constituent, was fully realized by Robinson.[22] The fact that *M. tuberculosis* is able to form compounds of a vitamin K nature and that the closely related *M. paratuberculosis* (Johne's bacillus) requires such substances as growth factors[23] suggested[24] what appears a highly promising investigation of the chemotherapeutic effect of sulphonamides possessing structural similarities to the anti-haemorrhagic compounds. Inhibition of succinic dehydrogenase by malonate affords a further example, and more recently ethionine, $C_2H_5S.CH_2.CH\left\langle\begin{matrix}NH_2\\CO_2H\end{matrix}\right.$ has been found by Harris and Kohn[25] to limit bacterial growth by competition with methionine. Fildes[26] showed that indole acrylate inhibited bacterial growth by virtue of its relation to tryptophane. Some aliphatic α-amino sulphonic acids inhibited growth by virtue of the relation to α-amino carboxylic acids, and pyridine, 3-sulphonic acid and its amids by relation to nicotinic acid.[27]

The latest product of this form of constructive reasoning, one which may prove to be of great therapeutic importance, has now been evolved.[28, 29] Pantothenic acid is an essential growth factor for many pathogenic bacteria, and an analogue which should be inhibitory is N-(α γ-dihydroxy, β, β-dimethyl butyryl–) taurine or pantoyl taurine. This substance, as theoretically predicted, inhibits the growth of bacteria requiring pantothenic acid. As in experiments with sulphanilamide and PAB, the presence or absence of growth depends on the

[18] Landy and Wyeno, *Proc. Soc. Exp. Biol. Med.*, *46*, 59, 1941; Straus *et al.*, *J. Clin. Investigation*, *20*, 189, 1941.
[19] Green and Bielschowsky, *Brit. J. Exp. Path*, *23*, 13, 1942.
[20] Dorfman *et al.*, *J. Bact.*, *43*, 69, 1942.
[21] McIlwain, *Biochem. J.*, *35*, 1311, 1941; *36*, 417, 1942; *Lancet*, *1*, 412, 1942; *Brit. J. Exp. Path*, *21*, 136, 1940; *22*, 148, 1941; *23*, 95, 1942; McIlwain and Hawking, *Lancet*, *1*, 449, 1943.

[22] Robinson, *J. Chem. Soc.*, 505, 1940; 488, 1942.
[23] Anderson and Newman, *J. Biol. Chem.*, *103*, 197, 1933; Almquist *et al.*, *Proc. Soc. Exp. Biol. Med.*, *38*, 336, 1938; Woolley and McCarter, *ibid.*, *45*, 357, 1940.
[24] Sjögren, *Nature*, *150*, 431, 1942.
[25] Harris and Kohn, *J. Pharmacol.*, *73*, 383, 1941.
[26] Fildes, *Brit. J. Exp. Path.*, *22*, 293, 1941.
[27] McIlwain, *Loc cit.* (*Brit. J. Exp. Path*, 1940, 1941).
[28] Snell *et al.*, *J. Amer. Chem. Soc.*, *62*, 1776, 1791, 1940; *J. Biol. Chem.*, *139*, 975, 1941; *141*, 121.
[29] McIlwain, *Loc. cit.* (*Biochem. J.*, 1942; *Brit. J. Exp. Path.*, 1942).

relative concentrations in the medium of pantoyl taurine and pantothenic acid. Similarly, the capacity of various natural fluids, such as muscle extract, plasma and urine, to antogonize the inhibitory action of pantoyl taurine varies with their content of pantothenate.

It is possible therefore to hope that the future approach to the production of new, *specific* chemotherapeutic agents will consist in modifying the structures of essential metabolites so as to produce substances which can no longer exhibit any specific action in the cell economy, but will still be able to block the enzymes concerned in the reaction. And this should not be a difficult task since at the present time, more than ever before, knowledge of the 'growth factors' and 'accessory growth factors' of many of the common pathogenic organisms is increasingly being made available.

BOOK REVIEWS

Chemistry and Pharmacy of Vegetable Drugs.—By Noel L. Allport, F.I.C. Published by George Newnes Limited, Tower House, Southampton, Strand W.C. 2, London. Pp. 264.

According to the author the book is 'designed to answer the many questions which must arise in the mind of the student of pharmacy, when making his preliminary acquaintance with numerous vegetable drugs'. For this purpose and also as an aid to the students of materia medica and pharmacology in the medical schools, the book will be eminently suitable and it is hoped, will be enthusiastically received. Years of teaching experience have impressed the reviewer with the need for more and more books which give a 'preliminary acquaintance' to the subject through an interesting mode of presentation and illustration of the subject matter, rather than profusely-documented and scholarly treatises. Both types of text-books are needed perhaps at different stages in the student's career, but it is essential for the maintenance of sustained interest, to start him on with something which he can swallow and swallow with avidity, leaving behind a desire for more. Mr Allport has succeeded in providing such a fare and the reviewer feels little hesitation in bringing the book to the notice of the different schools of pharmacy in India.

The book contains 264 pages divided into 22 chapters and an Index. The author has shown much good sense in not attempting the traditional 'botanical' classification of the vegetable drugs. This would have defeated the very purpose which the author has in view of assisting the student in his study of vegetable drugs. The system of grouping under 'botanical', 'chemical' and 'therapeutic' is most advantageous and the reviewer has adopted more or less the same system in practice at least for the last 6 years with good results. It is best, for example, to discuss (as has been done in this book) all drugs containing alkaloids or glucosides as their active principles under their respective 'chemical' headings and consider the chemically heterogenous groups of 'anthelmintics' under a 'therapeutic' classification. It is time that water-tight compartments, often observed in classification by systematists, are removed for a more rational and helpful grouping of the type adopted in this book.

Besides an easy presentation, the book is replete with illustrations and photographs. The practical handling of different apparatus and appliances is also shown wherever possible. Sufficient emphasis has been given to the assaying of the active ingredients both by chemical and by biological methods where considered important. There is every indication that the book has come to stay and will be liked by the students.

B. M.

Decibel Notation—By V. V. L. Rao, Radio Engineer. Published by Addison & Co. Ltd., Madras. Pp. 177, with 52 diagrams, graphs, charts etc. Price Rs. 8/12/-.

"The present work has been undertaken as, that so far as the author is aware, no work on this subject has been published in the English language, having a booklet of 57 pages by Morris," writes the author in the preface, and rightly so. The vast amount of useful information contained in the small book will be welcome to those interested in Radio and Acoustic Engineering. The author has collected the material which may be found scattered in text books on Radio or Acoustic measurements, but when the information is put together in a systematic and judicious manner, the reader finds it handy and convenient for consultation and the usefulness is greatly extended. In the present day of radio and audio broadcasting

the book may be used as a text-book to supplement the teaching of acoustics and radio communication, and as a guide to laboratory practice.

The author starts with the logical basis for decibel notation *viz.*, that perception of sound intensity is proportional to the logarithm of the acoustic power, and explains in the course of the following chapters the measurements of power in amplifiers with reference to the "zero level". Different methods are carefully dealt with and numerical examples are appended in each case—a very useful method in giving a realistic picture of the method that is described. The reader is led through the decibel method in measuring frequency response, hum etc. The subject of "attenuators" and "filters" have been exhaustively treated; except practical details the reader will find everything at hand if he wants to make an attenuator or a filter.

The technical terms in measuring sensitivity of microphones, and the acoustical performances of a loud speaker have been lucidly written; similarly the subject of audio acoustics has also been touched.

In order that the book may be used by students it is desirable that introductory remarks in relation to the apparatus and the formulæ should be included. References to the latter in all cases must be given. For instance, the formula relating to audio transformer have been tacitly assumed and used (page 92), *e.g.*, "the ratio of matching transformer" $\sqrt{500/50} = 3{\cdot}162$ etc. may be a difficulty to the student. The formula should be numbered and cross references should be given where necessary. The impression that the book represents a collection of formulæ should be removed, and stress should be laid on the method by a few introductory remarks and references. Much space could be saved if the author uses $10 \log P_2/P_1$ instead of $10 \log \frac{P_2}{P_1}$.

These remarks have been made in order that the author may attend to them in the second edition of the book; the writer congratulates the author on the most useful and readable book that he has written in the most technical subject. The students will profit by the constant use of this book in the laboratory.

R. N. G.

Wulff, E. V. 1943.—An introduction to Historical Plant Geography. Published by Chronica Botanica Co., Waltham, Mass. U.S.A. Pp. 223. Price $4·75.

This book was originally published in Russian, first in 1932 and then again in a revised form in 1933, and now it has been translated into English after incorporating some further improvements. It was intended to be followed by a second volume dealing with a history of the floras of the world and a third with the changes in these floras caused by the influence of man. Unfortunately, however, the author died a couple of years ago during the siege of Leningrad, being struck by shrapnel, and although the second volume is said to have been more or less completed, the third may never see the light of the day under Dr Wulff's name.

The author aims at a study of the distribution of the existing species of plants with a view to elucidating the origin and history of development of the floras, which in turn is expected to provide a clue to an understanding of the history of the earth. Of the eleven chapters comprising the book, the first explains the scope of the subject and its relationship with allied subjects; the second deals with the history of the science; the third with areas, their centres and boundaries; the fourth and fifth respectively with the origin and types of areas; the sixth with parallelism in the geographical distribution of plants and animals and a correlation between the distribution of parasites and their plant hosts; the seventh and eighth with the rôle of artificial and natural factors respectively in the geographical distribution of plants; the ninth with a discussion of the migration of species and floras; and the tenth with the historical causes for the present structure of areas and composition of floras. The eleventh and last chapter is concerned with the concept of floral elements and outlines the general principles that ought to be followed in making analyses of floras.

Of special interest, even to non-botanists, will be the information dealing with the rôle of artificial and natural factors in the distribution of plants and a discussion of the historical causes leading to the present composition of the world's floras. The author emphasises that in undertaking a study of this type, one has to consider two main points: (*a*) does the dispersal of a species takes place by sudden spurts, as a result of its chance penetration or transport into distant localities which are widely isolated from the main area, or, (*b*) is it mass-like in character, the species as a whole, gradually although perhaps unevenly, covering fresh territory until some barrier either climatic or geographical, puts a limit to its further spread? In the first case its discontinuous distribution is easily understood without any further explanation: in the second alternative this could only result from a dying out of the species in the intervening territories or the isolation of the occupied regions due to geological causes.

The author has dealt with the above points very critically and unemotionally. It is a common textbook statement that several natural agencies, such as wind, water and animals, can successfully transport

plants or parts of plants, such as seeds, to very considerable distances beyond their place of origin. It certainly appears quite comprehensible to the ordinary mind that strong *winds* may blow certain seeds and fruits, wither due to their lightness or other adaptations, to considerable distances from their place of origin, but the author shows that in actual practice this is very unlikely. We are told, for instance, that there is no proof of seeds having been carried by wind even from England to France or from Ireland to England. Then again, as regards *water*, this is certainly an important factor in the dispersal of plants along the shores of seas and lakes but it can hardly cause their inland penetration to any appreciable extent. Further, although rivers run long distances over land, they must often transport the seeds to places where they would be unable to establish themselves. Sea-currents also go a long way but they do not usually flow parallel to the equator, and even if the seeds, despite prolonged immersion in sea-water, preserve their germinating power, they are quite likely to be carried into places where the climatic conditions are entirely alien to them. Even if this were not the case, there would still remain the difficulty that unless they can be transported to a new area in *sufficiently large numbers*, they cannot succeed in establishing themselves as a component part of an already existing flora with which they will have to come into competition. Among *animals*, birds have often been credited with a long distance distribution of plants, by the seeds either adhering to their feet and feathers or being carried inside their alimentary canals to be voided later on in new and far off places. But here also, inspite of a careful study of the available information, the author failed to find a single case on record of the transport by birds of any plant that subsequently succeeded in establishing itself and extending its range in a distant habitat.

Man, admittedly, plays a far greater role in the distribution of plants, whether intentionally (as in the case of many cultivated plants) or unintentionally (as in the case of certain weeds). This is due mainly to the present extensive development of the means of communication and the constant movement of people from one part of the world to another, as well as to the expansion of cultivated areas and the introduction of cultivated plants from distant countries. One must however agree with Dr Wulff that even man's significance in the geographical distribution of floras was very much less in the past and that even now there are obvious limitations to it caused by differences of habitat.

Contrary to the general opinion (based more on imagination, however, than on a scientific appraisal of the existing data) the author concludes that plants are dispersed only slowly and gradually, gaining new territory step by step and not by spurts, and that an explanation of the present discontinuous distribution of our floras has to be sought elsewhere. For this he turns to the geological history of the earth, for there is no escape from the conclusion that lines of communication must have existed in the past between regions now separated by thousands of miles of ocean. The hypotheses of submerged continents, sunken land bridges and continental draft are discussed one after another as the possible clues for an explanation of the present and past distribution of plants. After evaluating all the existing theories of this kind, the author strongly inclines to the Wegener hypothesis which assumes that the continents are comparable to drifting icebergs detached from a once continuous mass. He draws attention to a general resemblance in outline and in geological structure between the eastern edge of S. America and the western border of Africa ; the Atlantic is then considered as a great rift which gradually broadened in the course of ages. South America, Africa, India and Australia were once united according to this view into a single vast continent called Gondwanaland which persisted through several geological ages but subsequently disrupted into smaller land-masses which have floated further and further apart into their present positions. The originally continuous distribution of a species would then become discontinuous owing to the sundering oceans which now separate these sub-continents. It must be admitted that the Wegener hypothesis has been subjected to severe criticism and the number of its adherents is perhaps small but from the support that it has received from some quarters during recent years and now from a plant geographer like Dr Wulff, it seems deserving of a more sympathetic consideration than it has hitherto received. The objections that have been raised against it "do not suffice to discard Wegener's theory as incorrect but only indicate that in this theory there is still much that requires further elaboration and modification. In any event its significance for biogeography is beyond doubt. It has thrown light on a number of hitherto entirely incomprehensible moments in the geography of plants."

While it is not possible to say that Dr Wulff has succeeded in establishing his thesis, he has certainly made a very thorough and critical study of a subject that is extremely vast and the information on which is widely scattered over different places. If the results of his analysis are not always clear, this is due to the paucity of any reliable and extended observations in this field rather than to any fault of his own. He may have *proved* little or nothing but none will deny him the credit of having *suggested* a great deal and it is here that the value of the book lies. It is the first of its kind in the English language and the

publishers are to be congratulated on having produced it during these difficult days, with the author in Russia and the general editor of the series, at first in Holland, and then in the United States. The only criticism which the reviewer would like to make is that he found the language and the style a little difficult in places so that it took him more time to go through the work than its size justified, but this is excusable in consideration of the fact that it is a translation from an alien language.

P. M.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

ON THE LINEAR SET UP LEADING TO INTRA AND INTER BLOCK INFORMATIONS

Many attempts have been made to make a critical study of the hypotheses and the laws of chance involved in the analysis of variance tests for field experiments. An extensive and important contribution is due to Dr Neyman[1] who starting with a suitable linear hypothesis found the limitations of the z-test devised by R. A. Fisher. This was subjected to much criticism by the Fisherian school and many of the statements advanced by them remain unstudied. The actual distribution of Fisher's z on Neyman's hypothesis has been found out in the case of randomized blocks by McCarthy[2] but it has not much practical utility.

The purpose of this note is to devise a linear set up which is of special importance in the field experiments and consider the problems of estimation and testing of hypothesis in the light of the article "On linear estimation and testing of hypothesis" published by the author elsewhere.[3] We shall consider the general varietal trial of which the factorial experiments can be deduced as a special case.

The problem is to test whether one variety is superior to another in a certain specified region. We cannot utilise the whole of the specified region nor is it desirable to choose a certain number of plots at random for one variety and a certain number for the other variety. Evidently two varieties cannot be tried one after the other on identical plots without vitiating the comparisons. So we choose sets of plots adjacent to one another which are called blocks. Let us consider a block of k plots and imagine a uniformity trial on these plots with the yields $Y_1, Y_2, \ldots Y_k$ and define the quantities

$$\beta = \bar{y} \text{ and } \eta_i = y_i - \bar{y} \quad . \quad . \quad . \quad (3\cdot1)$$

with the obvious restriction

$$\Sigma\, \eta_i = 0 \quad . \quad . \quad . \quad . \quad . \quad (3\cdot2)$$

If any variety is tried on the i-th plot then the yield T has the composition

$$T = \tau + \beta + \eta_i + \epsilon \quad . \quad . \quad . \quad (3\cdot3)$$

where ϵ is a technical error due to experimentation and is independent of β or η's. τ is called the effect of the variety. If $T_1, T_2, \ldots . T_k$ are the observed yields of k varieties tried on the k plots with random determination of positions then

$$T_i = \tau_i + \beta + \mu_i + \epsilon_i \quad . \quad . \quad . \quad (3\cdot4)$$

where μ_i can take any of the η's of (3·1). T_i's are obviously correlated variables. From this we construct k on other linear functions.

$$B = \frac{\Sigma T}{\sqrt{k}} \text{ and } R_i = \Sigma l_{ij}\, T_j$$
$$i = 2, 3, \ldots . k$$

such that $\sum_j l_{ij} = 0$ and $\Sigma\, l_{ij}\, l_i l_j = 0$ and $\Sigma\, l^2_{ij} = 1$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3\cdot5)$$

with the consequent relations

$$E\,(B) = \Sigma\tau / \sqrt{k} + \beta\sqrt{k} \quad . \quad . \quad (3\cdot6)$$
$$E\,(R_i) = \sum_j l_{ij}\, \tau_j \qquad i \geqslant 2 \quad . \quad . \quad (3\cdot7)$$

The variance of R_i is called the intra block variance σ^2_{ia} and is due to the variation of the comparisons from blocks of the same size together with a component due to ϵ. The variance of B in sets of blocks with the same β is however different from σ^2_{ia} and is caused by ϵ. If we have b, such blocks we get b$(k-1)$ equations of the form (3·7) from which we proceed to the problem of estimation and testing of hypothesis. The variables are all independent and the information supplied by them is called the intra-block information. The estimation of σ^2_{ia} is supplied by the minimised squares.

We can by a suitable device make use of the equations (3·6) in the estimates of the varietal contrasts. We choose all the blocks or those forming a complete replication close to one another and assign the b sets of treatments at random to these blocks. Any observed yield will then be

$$T = \tau + \mu + v_j + \eta_i + \epsilon \qquad (4\cdot1)$$

where $b\mu = \beta$ and v_j is a random variable assuming any one of the values $\beta p - \mu$, $p = 1, 2, \ldots . b$. The b equations of the form (3·6) will lead to

$$E(B_j) = \frac{\Sigma\tau}{\sqrt{k}} + \mu\sqrt{k} \quad . \quad . \quad . \quad . \quad (4{\cdot}2)$$

From which we construct b linear equations

$$G_1 = \Sigma B_j/b \quad . \quad . \quad . \quad . \quad . \quad . \quad (4{\cdot}3)$$
$$G_i = \sum_j m_{ij} B_j \quad i \geq 2$$

with the m's possessing the same properties as the l's of (3·5),

Then $$E(G_1) = \frac{\Sigma r_i \tau_i}{bk} + \mu \quad . \quad (4{\cdot}4)$$

where r_i is the number of times the i-th variety is used and

$$E(G_i) = \Sigma m_{ij} \Sigma_j \tau \quad . \quad . \quad (4{\cdot}5)$$

where $\Sigma_j\tau$ is the sum of treatment effects from the j-th block. The variance associated with G_i is called the inter block variance and is denoted by σ^2_{ir}. The estimating equations are $b(k-1)$ of the form (3·7) and $(b-1)$ of the form (4·5) with different variance and all independent of one another. The estimate of σ^2_{ir} has to found from (4·5). The information supplied by the relations (4·5) is called the inter block information.

The expressions for variances and covariances of contrasts are to be found as in the papers.[3, 4] The formulae discussed there hold good. The intra and inter block estimates can be found separately and added together with proper weights. The underlying assumptions and the actual methods of estimation and testing will be dealt with in a detailed paper to be published elsewhere, wherein the results given by Prof. P. C. Mahalanobis[5] on probable errors of field experiments will also be discussed. Further literature on this subject is found in the lecture notes of Mr R. C. Bose on the application of linear estimation theory to the design of experiments.

C. RADHAKRISHNA RAO

Statistical Laboratory,
Calcutta, 17-8-1944.

[1] Neyman, *J. R. S. S.* (*Supplement*), 2, 108-180, 1935.
[2] McCarthy, *Ann. of Math., Stat.*, 10, 337-360, 1939.
[3] C. R. Rao, *Current Science* (July Number), 1944.
[4] C. R. Rao, SCIENCE AND CULTURE, 9, 554, 1944.
[5] P. C. Mahalanobis, *I. C. A. R.*, 96-114, 1925.

SYNTHESIS OF THIAMIN BY GERMINATING SEEDS

VERY little work has been done on the accumulation of thiamin during germination and the stimulating influence of light on the process. In order to find whether thiamin is synthesised during germination and the influence of light, if any, on the process, experiments were carried out in the spring of this year with soya-bean and *kanch mung* (Phaseolus Mungo), germinating in the dark under properly controlled conditions of temperature, moisture etc. and exposing them to sun-light and ultra-violet rays of known wave-lengths for a definite period. Thiamin was determined by thiochrome method of Harris and Wang.[1] It has been observed that thiamin is formed during germination in the dark, and sun-light or ultra-violet light of wave lengths between 3000—400 Å stimulates the process considerably. Some results are given in the table below:

THIAMIN EQUIVALENT IN MG. PER CENT (DRY BASIS) OF GERMINATING SEEDS UNDER VARIOUS CONDITIONS

Seeds	Ungerminated seeds	Germinated seeds		
		In dark at 29-30°C.	Exposed for 6 hours at 29-30°C.	
			Sunlight	Ultra-violet between 3000-4000Å.
Soyabean	0·34	0·81	1·81	1·91
Kanch mung	0·42	0·90	1·91	2·10

Further work is in progress, in order to find in particular whether these observations are confirmed by the biological method of assay.

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[1] Harris and Wang—*Biochem. J.* 35 1051, 1941.

PHARMACOGNOSTIC STUDIES ON *LOBELIA NICOTIANAEFOLIA* HEYNE

'Tincture Lobelia' of 'British Pharmacopœia' and 'United States Pharmacopœia' are prepared from *Lobelia inflata* Linn. (Fam. Campanulaceæ), a plant indigenous to Canada and Eastern U. S. A.[1, 2, 3] The drug is considered to be a good remedy for asthma and chronic bronchitis. The most important constituent of the plant is the alkaloid 'Lobeline', which is considered as a respiratory stimulant and is particularly valued in cases of collapse due to poisoning by noxious gases and narcotics. Five other alkaloids which are less active and whose actions are also somewhat secondary have been further isolated.[4]

Recent pharmacognostic studies on *L. nicotianæfolia* Heyne. which is found in India frequently in the

region from Bombay to Travancore, in Malabar and in Ceylon[5] have revealed the following important characteristics.

Macroscopic—Stem erect, hollow, somewhat pubescent, leaves nearly obovate lanceolate, subsessile, nearly glabrous above, pubescent beneath; inflorescence, dense terminal raceme; flowers with ½ to 1 in. long peduncles; calyx 5-partite, somewhat hairy; corolla oblique, 2-lipped, upper lip 2-partite, lower 3-lobed; anthers connate; ovary inferior, 2-celled, ovules many, stigma—bifid; fruit-capsule; seeds small, ellipsoid, compressed, coarsely reticulate.

Microscopic—Hairs on stems and leaves are conical and unicellular. Transverse section of the stem shows the presence of well-marked endodermis and pericycle and latex vessels in the phloem. The pith of the stem is characterised by the presence of lignified and pitted parenchyma. The upper epidermis of the leaf is composed of straight-walled cells, and the lower of wavy-walled cells with many stomata. The mesophyll is characterised by the presence of single crystals and oil drops. Laticiferous vessels are present in the phloem of the leaf. The seed coat of the seed is composed of yellowish brown polygonal cells with thick walls.

From the above description it is found that it pharmacognostically resembles *Lobelia inflata* which have the following similar characteristics:—

Cylindrical but slightly angular hairy stem, irregularly denticulate margin of the leaves, acute apex, subsessile leaves 5-partite calyx, connate anthers, 2-celled ovary, capsular fruit small ellipsoid and coarsely reticulate seeds; conical and unicellular hairs on stems and leaves, latex vessels in phloem of stem and leaf; upper epidermis of leaf being composed of straight walled cells and the lower of wavy walled cells with plenty of stomata, lignified pitted parenchyma in the pith of the stem and seed coat of seed being composed of yellowish brown polygonal cells with thick walls.

A chemical assay of the drug revealed that alkaloids of 'Lobeline' group are present in some specimens of this plant in greater strength than that mentioned in British Pharmacopœia for *L. inflata* Linn. The total alkaloids, calculated as Lobeline was found to be 1·18 per cent in *L. nicotianæfolia* Heyne whereas according to recorded figures it varies from 0·3 to 0·4 per cent in *L. inflata* Linn. The drug consists of the dried aerial parts of the plant and it should not contain more than 60 per cent of stems and not more than 2 per cent of other organic matter.

Adulterant:—An examination of this crude drug obtained from dealers of the local market showed that it is often adulterated with or substituted by another plant *Verbascum thapsus* Linn. (Fam. Scrophulariaceæ). Its presence may be detected in the sample by the following characters.

Stems and leaves densely wooly; leaves oblanceolate, crenate; flowers in spikes; bracts longer than the flowers; stamens 5, fertile, 2 glabrous and 3 with white hairs; fruit capsule; seeds not reticulate; trichomes are branched and multicellular; glandular hairs 2-celled; epidermal cells strongly undulated; stomata broadly elliptical.

The plant *Verbascum thapsus* Linn. is known in Hindi as "Ban-Tamaku", a name which is also applicable to *L. nicotianæfolia* Heyne. This plant (*V. thapsus* L.) apparently does not contain the 'Lobeline' group of alkaloids in adequate proportions and as such the plant can never be proposed as a substitute for the B. P. drug *L. inflata* Linn. when *L. nicotianæfoloa* Heyne will fit in as a suitable substitute.

We are indebted to Messrs. Bengal Immunity Co., Ltd., for providing us the necessary funds for carrying on this work and to Dr B. Mukherjee, D.Sc., M.D., F.N.I., Director, Biochemical Standardisation Laboratory, who kindly carried on the chemical investigation of the plants.

The details of the paper will be published elsewhere.

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1 The British Pharmacopœia, 1932.
2 A text book of Pharmacognosy by Trease, 1938, London.
3 Pharmacognosy by Gathercoal & Wirth, 1936, U. S. A.
4 The Plant Alkaloids by Henry, 1939, London.
5 Flora of British India by Hooker.

ASSAY OF 'ENTERO-VIOFORM'

"ENTERO-VIOFORM" containing iodo-chlorohydroxy-quinoline as the main therapeutic substance is being locally prepared and standardised according to the method described in the New and Non-Official Remedies (1941 Edition) as modified by Pal and Guha.[1] But the recovery of iodine and chlorine from the tablets of various brands of the drug, or, from pure iodochlorohydroxy-quinoline itself, is not being found to be according to the N.N.R. requirements.

Iodochlorohydroxy-quinoline is a pure organic compound separating from glacial acetic acid in fine crystalline greyish-yellow needles, m.p. 177-178°C (uncorrected). As such there is no reason why its

halogen contents could not be rigidly ascertained. A method was, accordingly, been devised in this laboratory by which the percentage of iodine as well as chlorine could be accurately determined. This consists in first finding out the total halides in the form of their silver salts as usual, and subsequently estimating the percentage of iodine separately by the method of Pearl,[2] slightly modified. The percentage of chlorine can be easily calculated out by substracting the latter value of iodine from that of the total halides obtained as silver salts. The result of analysis from the average of three samples is being recorded in the table below—

Substance	Iodine %			Chlorine %		
	Found	Theory	N.N.R. value	Found	Theory	N.R.R. value
Powder ..	39·77	41·57	37·5 to 41·5	11·38	11·62	11·5 to 12·2

The details of the work will be published elsewhere.

My best thanks are due to Dr T. N. Ghosh for his interest and Dr U. P. Basu for his suggestions in this work.

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[1] SCIENCE AND CULTURE, *8*, 496, 1943.
[2] *Jour. Biol. Chem.*, *148*, 85, 1943.

AMINOMETHYL BENZENE SULPHONAMIDE IN THE CHEMOTHERAPY OF VIBRIO CHOLEREA

RECENTLY[1] *p*-aminomethyl benzene sulphonamide has been recorded to be a very useful drug in the treatment of infected wounds particularly for highly purulent cases of chronic sepsis. Work has also been in progress in this laboratory with the activity of this compound against various bacterial infections. The compound that is being used is its soluble hydrochloride[2] m.p. 250°. This was prepared from its acetyl derivative which again separates from water in fine prismatic needles, m.p. 175°.

The compound is being found to be definitely bacteriostatic against *vibrio cholerae* (types: Inaba and Ogawa). In a concentration of 1 in 10,000, it prevents the growth of the organisms in a medium made up of a glucose-phosphate-peptone broth. The medium is allowing a free growth of the test organisms. The drug is also somewhat effective against strains of *Bacterium Flexneri* and *Bacterium Typhosum*. The speciality of *p*-amino methyl benzene sulphonamide is, however, being more noticed in its characteristic power of inhibiting the growth of *V. cholerae* even in presence of *p*-aminobenzoic acid at a concentration as high as 20 μg. per c.c. The activity of the other sulpha-drugs like sulphaguanidine, sulphathiazole and sulphapyridine, was being inhibited under similar conditions even when the concentration of *p*-amino benzoic acid was so low as 0·05 μg. per c.c.

It would be of interest to see whether this promising *in vitro* results can also be obtained in cases of cholera infections in man.

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[1] Mitchell, *Lancet*, *1*, 627, 1944.
[2] Miller, et al, *Jour. Amer. Chem. Soc.*, *62*, 2099, 1940.

STUDIES ON PARALYTIC ILEUS

PARALYTIC ileus means loss of motor activity of the gastro-intestinal tract. The patients in such condition rapidly develop anhydraemia, hypochloraemia, hypoprotoenimia, azotoemia and disturbances in acid-base equilibrium in blood. The present author has critically studied the changes in *p*H *i.e.*, disturbances in acid-base equilibrium in blood with a large number of patients suffering from the diseases giving rise to paralytic ileus. It has been found that patients in such cases develop a base deficiency in alkalotic blood and the changes thus produced in blood initiate paralytic ileus and its progress, as well as damage the kidney resulting in azotoemia. Thus, it has been possible to find out the cause of paralytic ileus and also "why in cases of paralytic ileus azotoemia develops", which were hitherto unexplained.

Further work is in progress, the details of which will be published elsewhere.

The author offers his best thanks to Col. F. J. Anderson, Professor of Surgery, Medical College, Calcutta and Dr J. C. Gupta, School of Tropical Medicine, Calcutta for their kind encouragement.

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SPONTANEOUS EMISSION OF NEUTRONS FROM URANIUM

Sometime ago an investigation was undertaken in our laboratory for the detection of slow neutrons and slow protons produced in lead by highly energetic cosmic rays, with the help of a large proportional counter lined with baron and filled with CH_4. It was incidentally observed that the back ground count slightly increased when layers of U_3O_8 were kept in the immediate neighbourhood of the counter which was kept within a paraffin enclosure. It was surmised to be due to emission of neutron/proton from uranium because a strong source of γ rays did not affect the back ground count. As the increase in count was slight, not much attention was given to it. In view of our recent experiment on the "spontaneous fission of uranium",[1] it was considered worthwhile to look for neutrons which are usually emitted during such processes.

A small proportional counter was made from a brass tube 5 cms., in diameter and 15 cms. in length. The end pieces were made of ebonite with amber plugs and usual guard rings; a fine tungsten wire was stretched along the axis of the tube. The inside surface was coated with a thin layer ($\sim$0·1 mm.) of amorphous boron powder and the counter was filled with BF_3 to a pressure of 50 cms. The efficiency of such a neutron counter, defined as the fraction of a flux of neutrons which produces counts, is given by

$$E=(N_A\rho/\mu)\ R_B\sigma_B+NP\sigma_B L \qquad (1)$$

the first term of the right-hand side denotes the efficiency of the neutron counter due to boron lining while the second term denotes the efficiency due to BF_3 gas filling,

where N_A = Avogadro's number.

ρ = density of boron.

μ = at. weight of boron.

R_B = the range of α-particles in boron.

N = Loschmidt number.

P = pressure of BF_3 in atmospheres.

σ_B = capture cross-section of $_5B^{10}$ for thermal neutrons.

L = average path = diameter of the counter (approx.).

Thus the total efficiency of the counter is $\sim$10 per cent, each term contributing about 5 per cent to the overall efficiency.

The proportional counter was surrounded with a cylindrical double chamber containing U_3O_8 (equivalent of 800 gms. of uranium). The entire assembly was further surrounded with paraffin bricks of 5 cms. thickness. The counting rate was $1·8\pm0·2$ per minute above the back ground count of $0·3\pm0·05$ per minute. When the paraffin bricks were removed, the counting rate nearly dropped down to the back ground level. This indicated that neutrons were emitted from the uranium source, which after being slowed down by scattering in the paraffin bricks produced counts in the boron-filled proportional counter tube.

Assuming that the isotope $_{92}U^{235}$ is solely responsible for the spontaneous fission process, and that a single neutron is produced during a nuclear fission, the above emission of neutrons corresponds to a half-life of $\sim 2\times10^{15}$ years. A direct detection of fission fragments has yielded a half-life period of $\sim 10^{16}$ years. The discrepancy between the two values is probably due to the following causes:

(1) it is known that during a uranium nuclear fission, more than one neutron is produced; this will increase the half-life period.

(2) the proportional counter does not directly measure the number of fast neutrons crossing the counter volume, which are emitted by the uranium source; it measures the flux of thermal neutrons crossing it, produced by the slowing down and the scattering of fast neutrons in the surrounding paraffin shield. We have not yet been able to determine the ratio between the number of fast neutrons emitted by the uranium source and the flux of thermal neutrons crossing the counter.

More accurate experiment is in progress.

The author is indebted to Prof. D. M. Bose, Director, Bose Research Institute, for his kind interest and helpful suggestions. His thanks are also due to Prof. S. N. Bose for valuable discussions.

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93, Upper Circular Road,
Calcutta, 7-11-1944.

[1] S. D. Chatterjee and P. B. Sarkar, Science and Culture, 9, 560, 1944.

PHOSPHOLIPID METABOLISM IN EXPERIMENTAL SCURVY

It was reported that fatty livers develop in guinea pigs fed on a scorbutogenic diet and that

daily administration of 20 mg. of cholin had practically no effect in preventing deposition of fat in livers.[1] It was surmised that fatty livers of guinea pigs in experimental scurvy might be due to a failure in the transport of fat from the liver and that this failure is primarily due to decreased synthesis of phospholipids ; because it has been demonstrated that (*i*) phospholipid formation is dependent on tissue respiration and that the cytochrome system is intimately related with phospholipid synthesis[2] ; (*ii*) activities of succinic dehydrogenase, which is a cytochrome linked enzyme, and cytochrome oxidase of tissues of guinea pigs maintained on scorbutogenic diet is decreased.[3]

In order to test this hypothesis, studies were undertaken to compare the composition of the different lipid constituents, principally the phospholipids, of various tissues of normal and scorbutic guinea pigs. Analysis of the samples were always made 15—16 hours after the ingestion of last meals.

The experimental results are presented in tables I, II and III ; it will be seen that the level of

TABLE I

	ver		Kidney	
	Normal	Scorbutic	Normal	Scorbutic
Weight ..	5·9 g	7·6 g	1·6 g	2·0 g
Total lipid ..	6·25 g%	16·6 g%	5·75 g%	7·24 g%
Total phospholipid	3·62 ,,	1·68 ,,	2·49 ,,	1·54 ,,
Neutral fat plus unsaponifiable matter ..	2·63	14·9 ,,	3·25 ,,	5·69 ,,
Absolute amount of phospholipid in whole gland	213·58 mg	128·07 mg	39·92 mg	24·75 mg
Absolute amount of lecithin in whole gland ..	136·69	55·1 ,,	20·56 ,,	7·137 ,,
Absolute amount of cephalin in whole gland ..	59·80	56·2 ,,	13·60 ,,	11·96 ,,
Absolute amount of sphingomyelin in whole gland	17·09	16·70 ,,	5·76 ,,	5·645 ,,

(*a*) neutral fat plus unsaponifiable matter is increased several times in scorbutic livers and to a significant extent in the kidney—that of adrenals is lowered ; (*b*) lecithin of all the organs, excepting brain, (*c*) cephalin of kidney, intestine, adrenal and erythrocytes and (*d*) sphingomyelins of erythrocytes are

TABLE II

	Total lipid	Total Phospholipid	Neutral fat plus Unsaponifiable matter	Cerebroside
Brain (N)* ..	12·54 g%	6·52 g%	4·52 g%	1·5 g%
,, (S)† ..	,,	,,	,,	,,
Plasma (N) ..	—	90·4 mg%	—	13·7 mg%
,, (S) ..	—	81·0 ,,	—	33·2 ,,
Intestine (N) ..	2·76 g%	1·27 g%	1·49 g%	—
,, (S) ..	2·43 ,,	0·96 ,,	1·47 ,,	—
Adrenal (N) ..	16·2 ,,	4·2 ,,	12·0 ,,	—
,, (S) ..	12·8 ,,	2·94 ,,	9·82 ,,	—
Erythrocytes (N)	—	100 mg%	—	39·8 mg%
,, (S)	—	85 ,,	—	88·6 ,,

* (N)—Normal.
† (S)—Scorbutic.

TABLE III

	Amount per 100 g of brain, intestine and adrenal. Amount per 100 cc of plasma and erythrocytes.		
	Lecithin	Cephalin	Sphingomyelin
Brain (N)	1108·4 mg	3586·0 mg	1825·6 mg
,, (S)	,,	,,	,,
Intestine (N)	610·0 ,,	470·0 ,,	190·0 ,,
,, (S)	444·0 ,,	330·0 ,,	186·0 ,,
Adrenal (N)	1976·0 ,,	1720·0 ,,	502·0 ,,
,, (S)	1296·0 ,,	1140·0 ,,	504·0 ,,
Plasma (N)	41·2 ,,	30·2 ,,	19·0 ,,
,, (S)	32·0 ,,	30·0 ,,	19·0 ,,
Eryhrocytes (N) ..	16·0 ,,	62·0 ,,	32·0 ;,
,, (S) ..	12·0 ,,	47·0 ,,	26·0 ,,

below normal ; (*e*) cerebrosides of plasma and erythrocytes are above normal.

The details will be published elsewhere. My thanks are due to Dr B. B. Sircar and Mr P. B. Sen for their encouragement and interest.

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Calcutta, 7-11-1944.

[1] Spellberg and Keeton—*Am. J. Med. Sci.* *200*, 688, 1941.
[2] Taurog, Perlman and Chaikoff—*J. Biol. Chem.* *145*, 281, 1942; Fries, Schachner and Chaikoff—*J. Biol. Chem.*, *144*, 59, 1942; Fishler, Taurog, Perlman and Chaikoff—*J. Biol. Chem.*, *141*, 809, 1941.
[3] Harrer and King—*J. Biol. Chem.*, *138*, 111, 1941; Phillips, Stare and Elvehjem—*J. Biol. Chem.*, *106*, 41, 1934.